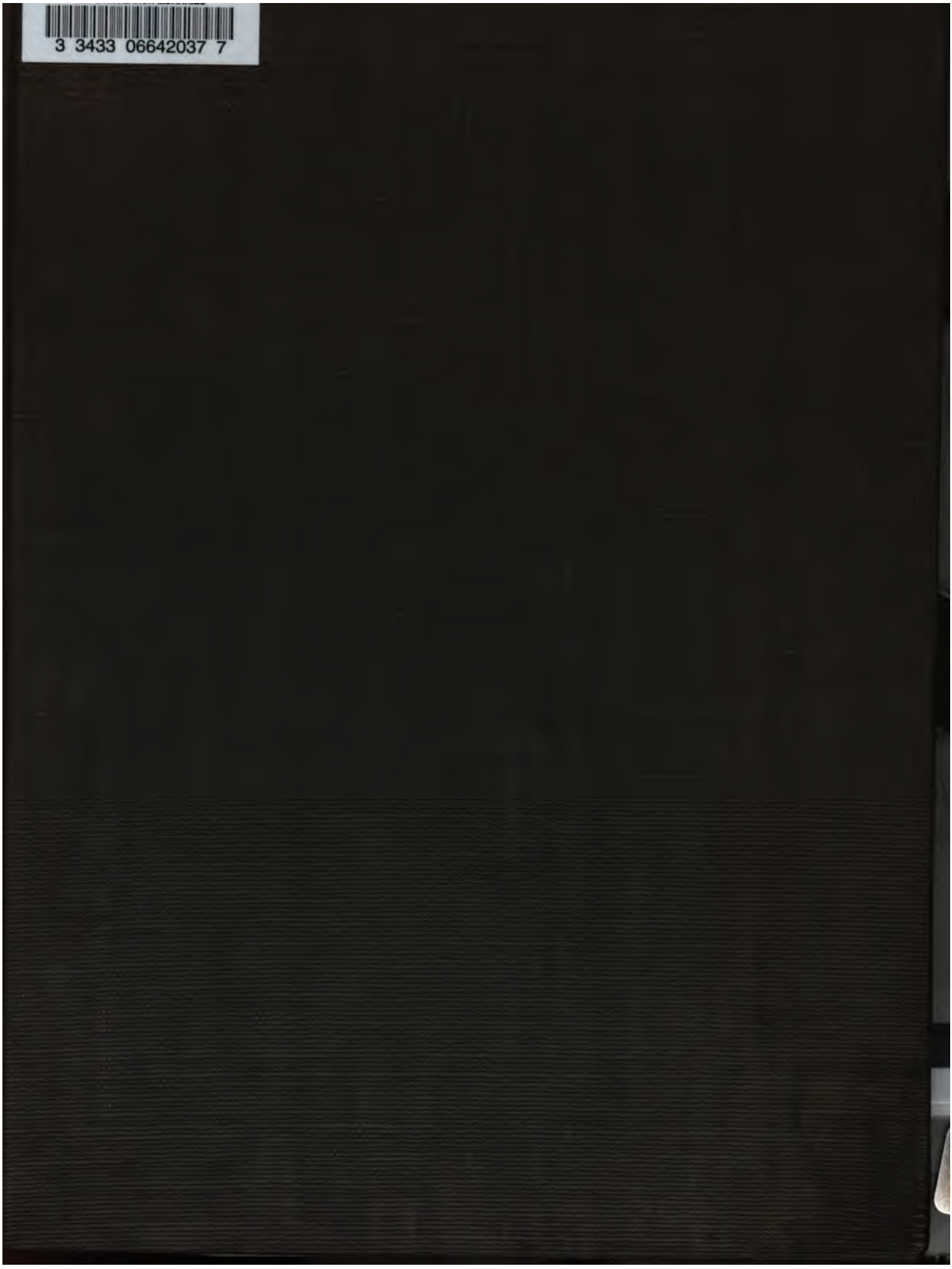


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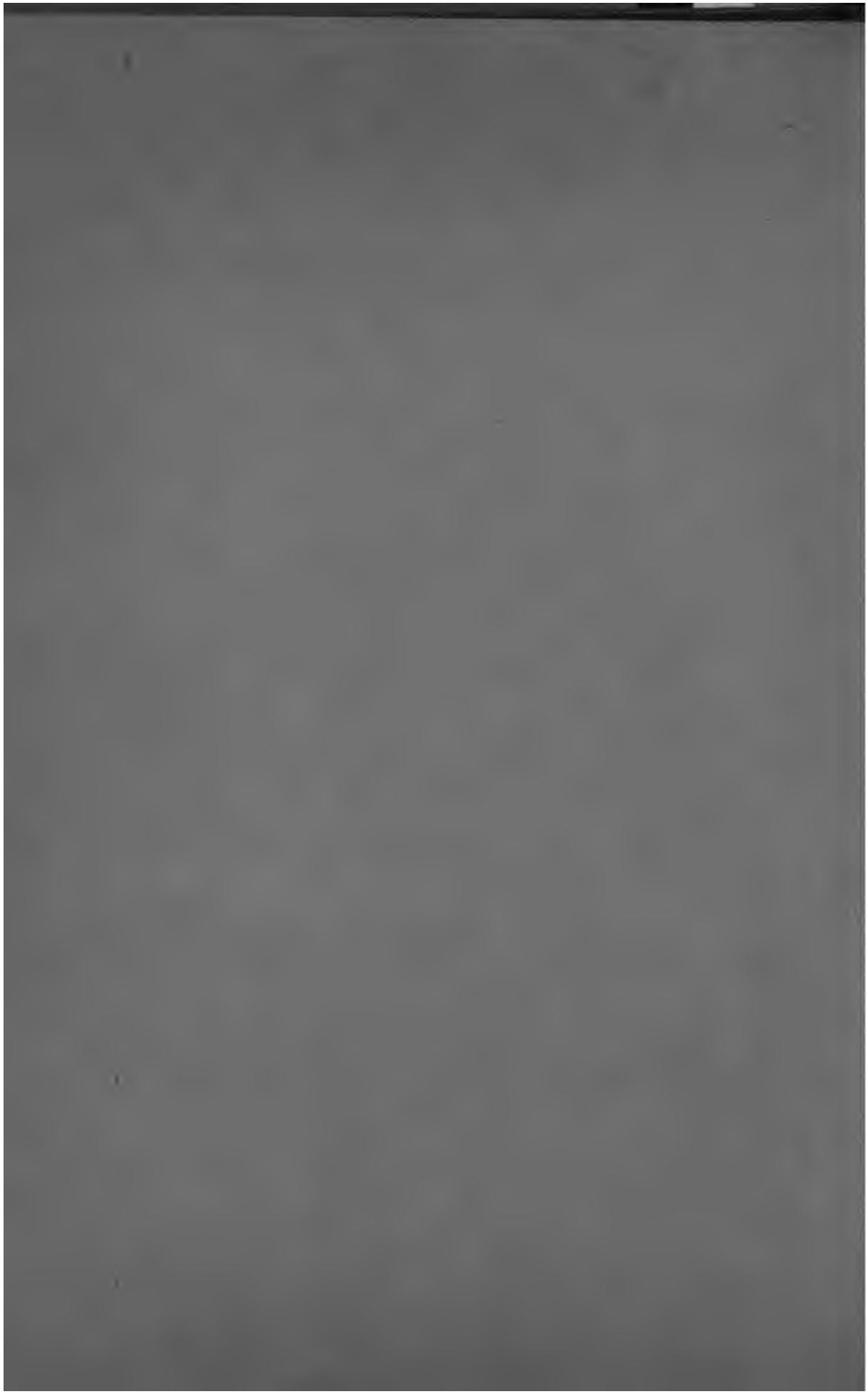
BRIEFS

ON

PORTLAND CEMENT

AND

CONCRETE.



ARGUMENTS PRESENTED

BEFORE

COMMITTEES ON CONCRETE AND FIREPROOFING

AND

STEEL & IRON CONSTRUCTION, STRENGTH OF MATERIALS

OF THE

COMMISSION FOR THE REVISION

OF THE

Building Code of New York

FEBRUARY 14, 1908

BY

ROBERT W. LESLEY, ASSOC. AM. SOC. C. E.,
Chairman, Committee representing Association American Portland Cement Manufacturers.

RICHARD L. HUMPHREY, M. AM. SOC. C. E.,
Secretary, National Advisory Board on Fuels and Structural Materials.

ROSS F. TUCKER, M. AM. SOC. C. E.,
President, Concrete Association of America.

COMMITTEE.

JAMES C. McGUIRE, *Chairman*,
WILLIAM P. KENNEALLY
CHARLES G. SMITH,
ANDREW P. EAGAN.

Cement and concrete — Specifications

Concrete construction —

INTRODUCTION.

On behalf of the various organizations interested in CONCRETE and PORTLAND CEMENT, the following arguments before your COMMITTEES have been compiled and are herewith presented.

ARGUMENT

By

ROBERT W. LESLEY, Assoc. Am. Soc. C. E.

Chairman, Committee representing Association of American Portland Cement Manufacturers.

Mr. Chairman and Gentlemen, I have in my hands a City Record of Friday, December 6, with the old Code, and in pursuance with the suggestions of your Chairman, I am going to assume that this is the backbone of the new code, at least, and talk upon it. I may be all wrong in this, but it is at least something which is tangible, to begin with.

As far as the difficulties of the actual specifications of cement are concerned, there are a number of slight changes, and slight imperfections in your specifications, and as the large engineering societies, the American Society of Civil Engineers, the Association for Testing Materials, the Railway Maintenance of Way Association, and the American Institute of Architects, Association of American Portland Cement Manufacturers, and in fact all the scientific societies—have joined in a specification which is known as the standard specification of cement, I feel sure in considering this matter of the exact requirements of cement, your Chairman and your members will not need anything from me. Much greater brains, much more study, and much wider knowledge has been bestowed upon that subject than I, with my limited knowledge could bring to you.

The specification speaks for itself, and I am sure that your Committee will consider that as the best that an able body could give.

Now, in preparing your New York specification for cement, it has been handled in many paragraphs, very cleverly, because the standard specification embraces in two reports the methods of testing of the American Society of Civil Engineers, and the specifications of the Association for Testing Materials, which was ratified by this Committee, and you have included in your requirements in single paragraphs the matter of specifications and the matter of testing very well, and many of the requirements here are entirely correct and proper, but probably there

are many little changes yet which you are considering, as coming from a body much higher than the cement industry itself, I will therefore take the opportunity of making a single suggestion.

This suggestion is an interesting one, and I think will merit your attention.

Sand and cement are used together for a composition, in the proportion of one of cement to three of sand in most specifications.

You devote two pages to telling what the cement shall be, and two lines to telling what the sand will be. I feel sure when you consider the proportion of sand to cement you will make some specification for sand which will require a certain percentage of strength of the sand mortar to the specification for mortar of the standard sand, and make some requirements as indicative of the quality of the sand.

I feel sure the sand you have in New York, is better than any standard sand, and am convinced that New York can take a step forward in that way, by determining what your sand mortar strength shall be, as compared to mortar with the standard sand.

Now, so much for those two things, which I am sure are for the safety and welfare of the citizens of New York, who have put this matter into your hands. I only want to go into one or two things more, because there are some other gentlemen who are much more familiar with the subject than I am, and what I have to say relates to the use of cement in buildings and the restrictions governing it.

In paragraph 117 you define what is concrete construction, and what are the carrying properties in concrete, and what the iron is to take, and what the cement is to take. You then limit the construction tc Section 113, which is to second class buildings.

Further on, in Section 31, you describe what class that is, which embraces the great bulk of manufacturing and mercan-

tile buildings in New York, and restrict the use of concrete so far as those buildings are concerned, to the garages and various different buildings of that class, excluding it from the better grade in Class E.

With this brief reference to the Code as originally adopted by the Committee, I certainly do not believe that in these days of concrete construction in this country and abroad, with the records that concrete has made in the cities of San Francisco and Baltimore, wherever it has been exposed to fire, and with the records right here in New York, that you intend to exclude concrete from the class of buildings to which steel and hollow tile construction and brick construction are admitted.

For the purpose of illustration in my argument, the records of building construction in your own city show that as a matter of comparison, the steel buildings with hollow tile protection is surpassed, so far as fire risk is concerned, by the concrete building.

In a recent issue of Cement Age, photographs of two buildings are shown, face to face, and the eye can see at a glance the very slight effect of fire upon the concrete building, and the almost total destruction of the other building of steel and hollow tile construction. Other illustrations, similar to this, have occurred in Brooklyn and at other points in New York City.

For the purposes of argument, however, I am ready to admit that concrete is neither better nor worse than any other fireproof material, and I am frank to say that I do not believe a man ought to come here and argue in the broadest way about a thing in which he is interested, but I believe that the evidence which has been brought out by the cases above mentioned, and further by the well known experiments conducted by Professor Woolson of Columbia University, that it is practically and conclusively established, that concrete is the best fireproof material, by reason of its great non-conductivity.

If you will then consider the fire experience shown in this country, and the record that concrete construction has, you

will then go a step further, and say, "How shall the iron or steel members, which are the carrying members of reinforced concrete, be protected?" At this point, we shall ask you to put concrete upon an equality with any other building material; to make no discrimination between it and other forms of construction.

Referring to the methods described in the Code, of iron and steel construction, and the amount of hollow tile and other protective materials, which must go around the carrying members, we find certain variations in the web of the hollow tile, and certain requirements necessitating a protection of nearly four inches. This is a wise requirement and the Parker Building fire showed this necessity, and your Code Committee, if this be its work, is entirely right in properly protecting every carrying member of a building, and it cannot go too far in this direction.

Now, I say if concrete, which is all a solid mass, and which is admittedly a non-conductor of fire,—and in all great fires, the surface destruction was about all that could be found with concrete,—I say that if those gentlemen who represent the concrete construction in this City of New York will come before your Committee and say, "We are ready to submit to whatever restrictions on the protection of our steel and iron carrying members that any other form will submit to,—if you demand four inches of hollow tile, we will give you four inches of concrete; if you ask for five, we will give you five,"—I say there ought not to be a distinction in the conditions of the requirements, as it exists to-day, between hollow tile, concrete, or any other form of protective material entering into the construction of a building.

Therefore, I urge upon the Commission, that the paragraph 117 on page 12, 707, restricting concrete to section 113, be modified so that concrete may be considered first class construction, and therefore be admitted to the erection of all buildings in Class E.

Now, I am sure that these are things, when the matter is brought before you that you will readily understand, and I feel that with the knowledge and experience that you all have,—and certainly you are all anxious to acquire that knowledge,—there will be no distinction between concrete and any other form of protective material.

Now, I go a step further, although I believe,—and I may be wrong in bringing it up, because it may be out of the province of this Committee—but I believe that when the broad question as to concrete in comparison with other forms of building material is decided, then your Committee on Height and Area will be able to consider to what height and what area concrete buildings ought to be, and make no unfair restriction as compared with other materials.

In other words, if these restrictions in these paragraphs that I have enumerated are the glasses through which concrete has been looked at, and if the blue glasses which have to this extent been used for these paragraphs, are changed into the pink glasses, I hope you gentlemen will see with them, it is my opinion that all these objects will seem pink, so far as concrete is concerned, and that any suggestions that have been made with reference to buildings and with reference to the height of buildings, will be guided by the pink light, and in the favor of concrete, and that its use will be unrestricted.

ARGUMENT PRESENTED

BEFORE

COMMITTEE ON LIMITATION OF HEIGHT AND AREA

OF THE

COMMISSION FOR THE REVISION

OF THE

Building Code of New York

MARCH 6, 1908

BY

ROBERT W. LESLEY, ASSOC. AM. SOC. C. E.,
Chairman, Committee representing Association of American Portland Cement Manufacturers.

COMMITTEE.

CHARLES G. SMITH, *Chairman*,
THOMAS L. HAMILTON,
EDWARD F. CROKER,
PATRICK J. BYRNES,
CHARLES H. CULLEN.

MR. CHAIRMAN AND GENTLEMEN: The field has been so well covered by the gentlemen who have preceded me that I am sure there is but a word to be added.

I will simply ask permission to present a little brief of what we have to say on this subject, and merely say this as a word perhaps on behalf of those who have developed this large industry in this country.

Portland cement, in the manufacture of concrete, is certainly, through the long record it has had, come to be acknowledged as permanent.

In the construction of buildings up to great heights it has been shown by all these figures, and will be shown by the records which the two previous speakers will give you, to be thoroughly adequate.

Its fireproof qualities I think are unquestioned to-day, in both the practical sense of the men who use it and who do not carry insurance, and in the men who use it and who do carry insurance, much to the pleasure of the insurance men who do not have to pay losses.

Now, the two cases which were spoken of here in New York, as examples of fires in concrete buildings—of these one was a very striking example. This fire was in the cork factory in Brooklyn. I think the name was Thompson & Norris. The fire took place in a room on the seventh or eighth floor, which was filled with all kinds of inflammable material, such as cork chips and material of that kind, where the heat was so great that the stream of water which was thrown on to the floor was turned to steam, and where, during the fire itself, the manufacturing operations in the rest of the building were not interrupted at all, other than the natural curiosity of the employees sticking their heads out of the windows to find out where the fire was.

In that particular fire the loss to the building itself was $50., as shown by the insurance proof, and the loss on merchandise, as it was given to me, was stated to be $5,000., show-

ing how the fire was restricted to a single room and how little damage was done to the building.

In another case, which was published in a magazine, the " Cement Age ", there appears on opposite pages photographs of two buildings, one the Parker Building and the other the Huyler Building.

The Parker Building speaks for itself so far as permanence in fireproof construction is concerned. There is not much necessity of dwelling on the subject of fireproof construction as regards that building. A glance shows it to have been fully wrecked.

On the other hand, the Huyler Building shows somewhere about the seventh or eighth floors a streak across the front where the windows have been knocked in and where the fire has been confined to that single floor.

Now, that is an illustration which merely goes to show that if concrete is to be judged it should be judged as a tried and demonstrated material; that it should have no preference over any other form of construction but that it should be accorded the same fair treatment that every material expects at your hands, and that the restrictions on height should be those restrictions which engineering economics of construction will warrant, and that concrete shall not be restricted any more than any other material.

I thank you for your consideration, gentlemen.

NOTE: The speaker before the Joint Committees on Concrete and Fire Proofing, and Steel and Iron Construction, Strength of Materials, presented an argument on the value of cement and concrete as a fireproof building material, and reference is made thereto, in case your committee desires further information.

ARGUMENT

By

RICHARD L. HUMPHREY, M. Am. Soc. C. E.

Secretary National Advisory Board on Fuels and Structural Materials.

Mr. Chairman and Members of the Committee: I appear here this afternoon as a friend of concrete and for the purpose of pointing out to you, if possible, some instances in which I think your predecessors have been unfair in dealing with this material.

As a whole I believe the code, which was reported by the previous Commission to the Board of Aldermen on December 2nd, 1907, and which I understand is the basis of our discussion to-day, is very good.

The work which you are engaged on is very important, more so, than, perhaps, you appreciate, since the code which will result from your work, if properly done, will be of great benefit, not only to the City of New York but to other cities of the country, who will unquestionably copy that code in part or as a whole.

It is, therefore, of the greatest importance, that the code finally decided on, shall be the best that can be devised, absolutely fair in every particular.

It seems to me, therefore, that it behooves the members of your Commission to be unusually careful to frame a code that will serve not only for the local interests of New York, but for other parts of this country as well.

It is because of this importance that I am here to-day.

One of the most important questions to be considered in framing a code of this character are the requirements for the various building materials. It seems to me that these requirements should be so fixed as to determine definitely the grade or standard required.

I will not take your time in describing the good work which has been going on in the development of a standard specification for cement, as I believe, Mr. Chairman, that you and the members of your Committee are familiar with it. It will be sufficient to state that this specification has been adopted by the various national societies, railroads, municipalities, many

branches of the government and is widely recognized as the standard. It is not therefore an experiment, and it has been fully demonstated that a cement which meets its requirements is in every way suitable for use for all construction purposes.

I have recommended, therefore, its adoption by your Commission.

Concerning the question of sand, it seems to me unwise to regulate the quality of this material by comparison with standards or samples kept in the office of the Superintendent of Building's. There should be a definite specification, setting forth distinctly what the requirements are, and upon a basis which everyone can compete intelligently. This would eliminate all question of judgment.

The same holds equally well for crushed stone and gravel ; A definite specification should be prepared setting forth fully the requirements for these materials.

The code as a whole should be concise and different working stresses should not appear in its several parts. The working stresses should be assembled in one place and should be harmonious.

This applies particularly to the working stresses for different materials as for example steel and concrete. A working stress of 16,000 pounds is allowed on the steel in reinforced concrete, while the allowable stress on the concrete is variously stated from 250 and 500 pounds. If the allowable working stress on the steel is 16,000 pounds then for a 1 : 2 : 4 concrete the allowable stress on the concrete should be materially higher than the maximum value given, if the two are to be proportionately stressed.

The limitation placed on the height to which a reinforced concrete building can be erected is unfair, for the reason that the allowable working stresses for each material is set forth in the code and this determines the height to which a structure of such material can be erected. The laws of design determining the maximum height from these working stresses.

Aetna Building
San Francisco, Cal.
Showing effect of fire on granite.

Hobart Building,
San Francisco, Cal.
Showing effect of fire on granite, and the failure of structural columns of this material

To state specifically that such structures shall not exceed 85 feet is arbitrary and an unjust discrimination, when you consider the appended list of structures over 85 feet in height, which have been erected of reinforced concrete and are in successful use, and which further serve to demonstrate the safety of such structures.

The appended argument on this subject which was made before the Committee on Limitation of Height and Area is submitted as a part of this argument.

The question of inspection is to my mind one that deserves careful consideration.

The most effective inspection possible will not prevent dishonest workmanship, if there is a desire on the part of the contractor to do dishonest work. No code can prevent this condition.

It would appear that the question of requiring a bond guaranteeing that the erection had been done in full accordance with the plans and specifications submitted and approved by the Superintendent of Buildings might place the responsibility on the owner or contractor and thereby greatly eliminate this danger.

The requirement for such combined load and fire tests as the Superintendent of Buildings may require, is unnecessary and it will hardly accomplish the desired end.

The best tests are those which are obtained in great conflagrations.

The tests required by the code while valuable do not afford an exact means of predicting what will happen under other conditions.

It is possible and borne out by experience that structures can be erected to meet the requirements of the load and fire tests even though the first attempt may fail. It is also true that the structure that passes the test may fail under other conditions.

The properties of fireproofing materials are sufficiently

established that we can foretell with reasonable accuracy the behavior of fire proofed structures in a fire.

The proposed code of the former commission placed reinforced concrete in second class construction; this is unnecessarily severe and unfair since it can be made as fireproof as any material.

There is a fallacy that concrete by reason of its high resistance to fire requires no fireproofing when used as a structural material. Structural concrete requires protection from fire just as steel or any other material requires to be fireproofed.

If therefore a reinforced concrete column is required to be 10 inches in diameter in order to sustain its load, then the actual size should be 10 inches plus the thickness of concrete required for fireproofing purposes.

As to what this thickness should be the code should of course regulate but it should not be greater than that required for any other material, particularly in view of the fact that of the fireproofing materials concrete is one of the best.

I do not consider it worth while to dwell particularly or at length on the San Francisco and Baltimore conflagrations as proof of this statement, for any one who is unbiased and unprejudiced who will study the records of these disasters will find abundant proof that concrete is at least as good and generally better than the best fireproofing materials.

Many forms of materials used for fireproofing purposes and considered of the highest type, fail under test because while the material in itself is fireproof, it is not so in the form in which it is fabricated. I believe this commission is taking a very important step in the right direction when they designate an increased thickness of web for certain forms of fireproofing material.

In connection with the aggregate to be used in concrete intended for fire proofing purposes a few words might be said.

Mills Building
San Francisco, Cal.
Showing effect of fire on terra cotta tile. Extensive failure of webs due to expansion of the tile from heat

Bullock-Jones Building
San Francisco, Cal.
Showing buckling due to the failure of terra cotta tile to protect the steel columns

Limestone or other materials likely to be injured by heat, provided all under a ¼ inch screen is removed, may be used in concrete if the stones are kept back from the exposed faces. Limestone screenings should not be used as the mortar made from it would be exposed and thereby seriously injured by fire. A silicious sand mortar such as required by the code would serve as a protection and if the limestone is kept an inch or more from the face, little or no damage would be done to the limestone by fire.

One more point in favor of concrete as a building material and an exceedingly important one is that no code should discriminate against a material through whose use an owner can secure a building so fully complying with the fire proofing requirements as to enable him to obtain the lowest rate of insurance, and further secure a building possessing great rigidity and durability for the least expenditure of money.

If the members of this Commission have doubts on this point I would recommend for their consideration the large number of successful structures of this type of construction which have been erected all over the country. I submit herewith in detail a discussion of various sections of the proposed code together with the revisions recommended.

Aronson Building
San Francisco, Cal.
Concrete floor arches intact. Note effect of fire buckling the steel columns through failure of encasing Terra Cotta Tile

SUGGESTED REVISIONS OF PROPOSED BUILDING CODE FOR NEW YORK

By

RICHARD L. HUMPHREY, M. Am. Soc. C. E.

The writer desires to suggest the following changes in the revision of the Building Code for the City of New York as reported to the Board of Aldermen on December 2, 1907 by the Committee on Buildings:

SECTION 35. Strike out the following: "The height of buildings with either walls, columns or girders constructed of reinforced concrete shall not exceed 85 feet." This restriction is entirely unnecessary for the reason that the height of such structures is fixed by the code itself which provides for the working stresses to be used in the design of such structures.

If it be safe and proper to erect buildings eight or ten stories high, it is just as safe to erect them as high as the rules of design will permit, using the allowable working stresses provided.

Tall buildings of reinforced concrete are not experiments. Their safety has been demonstrated in the erection of buildings of this type in sufficient number to remove all doubts on the subject. While it is true perhaps that buildings of this type in process of construction, by reason of bad design, workmanship or materials, have collapsed, it should be equally borne in mind that structures of steel and frame construction in process of erection, and even after erection collapse, yet the safety of such structures is not questioned because by reason of the great number of such structures which are safely and satisfactorily performing the work for which they were designed, everyone realizes that such failures must be due to gross carelessness or ignorance.

It is a fact that structures of reinforced concrete when once erected do not collapse.

It may be proper in all types of buildings, in order to decrease the fire hazard, to limit the height to a point at which the fire department can effectively fight a fire in such structures.

Such limitations as to height should not discriminate in the case of buildings of fireproof construction.

After Section 45, substitute the following: All sand shall be washed, clean, coarse siliceous sand, free from clay, loam or other foreign material. It shall all pass a one-quarter inch screen and be uniformly graded down to the finer size. Not more than 6 per cent. shall pass a sieve having 100 meshes per linear inch. The percentage of voids shall not exceed 38%.

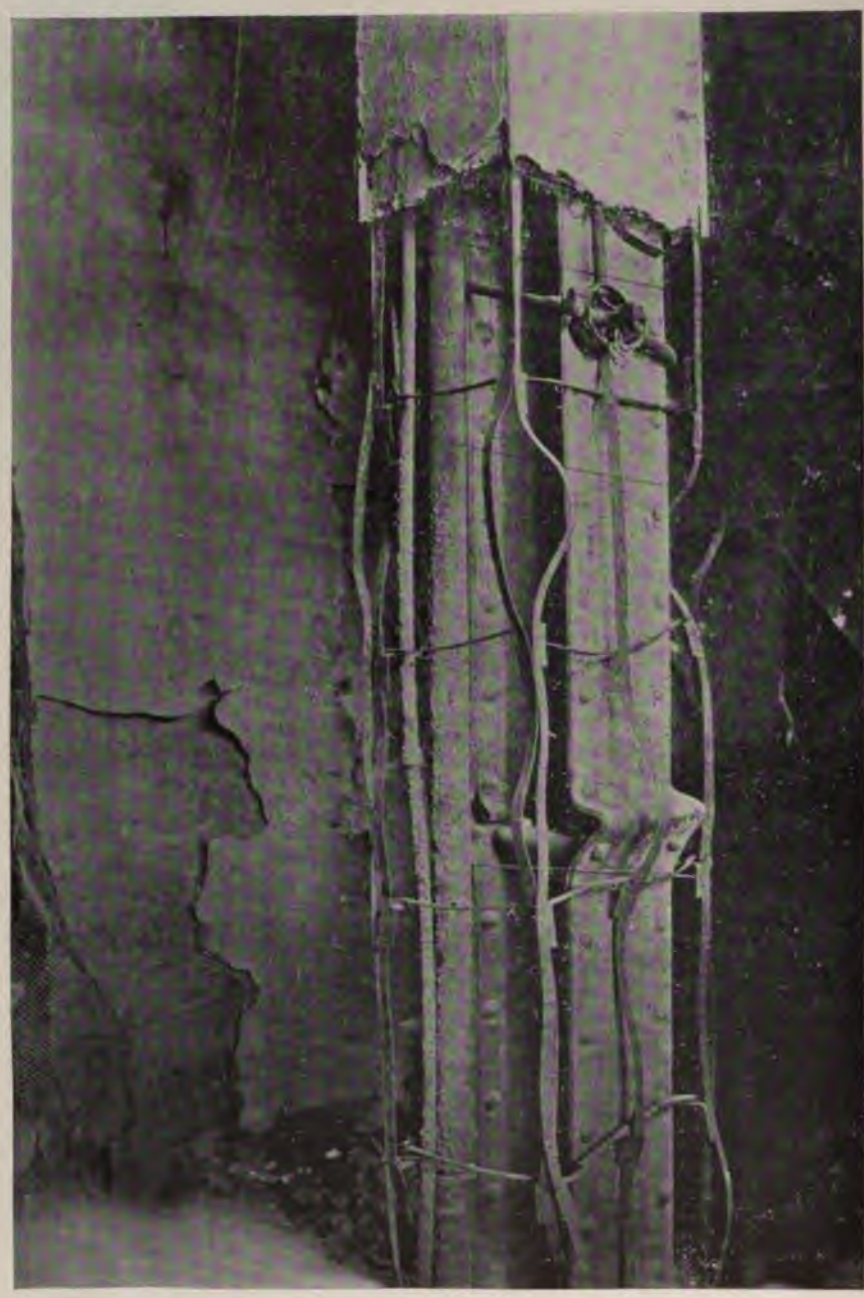
The present specification for sand is too indefinite. It should be such that there can be no uncertainty as to what is required. The only practical way of determining the size of a sand is to pass it through standard sieves and it would seem therefore proper to state the size required.

Extensive experiments by the U. S. Geological Survey at St. Louis with sands obtained from many parts of the country demonstrate that the strength of mortars made from these sands is dependent upon the density which is dependent on the gradation in size of the grain and is not materially effected by the sharpness of the sand.

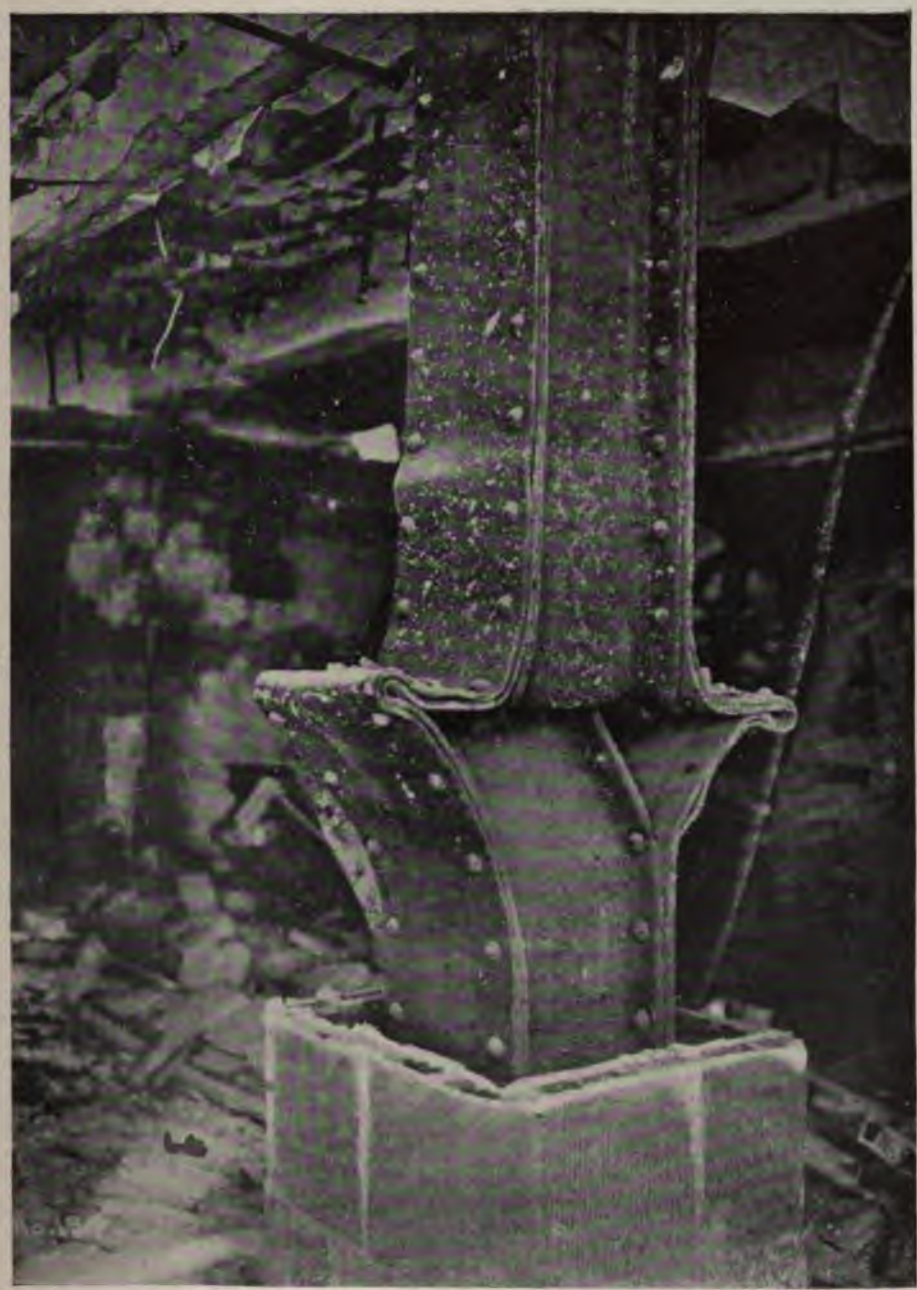
The standard requirements for cement based on uniform methods proposed by a special committee of the American Society of Civil Engineers, and adopted by the principal societies of this country and generally regarded throughout this country as the standard, is one which will secure a cement of the very highest quality suitable for all classes of work. For the purpose of maintaining this standard, Section 47 has been revised to conform to the standard.

SECTION 47. CEMENT AND CEMENT MORTARS. The term Portland cement is applied to the finely pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous materials, and to which no addition greater than 3% has been made subsequent to calcination.

The specific gravity of Portland cement shall not be less than 3.10



Hotel Hamilton
San Francisco, Cal.
Showing effect of fire on wire lath and plaster. Note buckling of steel column due to insufficient protection against fire



Aronson Building

San Francisco, Cal.

Showing the effect of fire buckling a steel column "Protected" by terra cotta

92 per centum of the cement must pass through a sieve having 10,000 meshes per square inch and 75 per centum through a sieve having 40,000 meshes per square inch.

The cement shall not acquire its initial set in less than thirty minutes and must have acquired its final set in not less than 1 hour nor more than 10 hours.

Pats of neat cement about three inches in diameter, one-half inch at the centre, and tapering to a thin edge, shall be kept in moist air for a period of twenty-four hours.

(a) A pat is then kept in air at normal temperature and observed at intervals.

(b) Another pat is kept in water maintained as near 70 degrees F. as practicable, and observed at intervals for at least 28 days.

(c) A third pat is exposed in any convenient way in an atmosphere of steam, above boiling water, in a loosely closed vessel for five hours.

These pats, to satisfactorily pass the requirements, shall remain firm and hard and show no signs of distortion, checking, cracking or disintegrating.

Standard sand used for testing shall be a clean quartz sand screened to pass through a sieve having 20 meshes per linear inch and retained on a sieve having 30 meshes per linear inch. The wires to have diameters equal to one-half the openings. Sand having passed the 20 mesh sieve shall be considered standard when not more than 1 per centum passes the 30 mesh sieve after one minute continuous sieving of a 500 gram sample.

The minimum requirements for tensile strength for briquettes one square inch in section shall be as follows and shall show no retrogression in strength within the period specified :

NEAT CEMENT.

24 hours in moist air	175 lbs.
7 days (1 day in moist air, 6 days in water)	500 "
28 days (1 day in moist air, 27 days in water)	600 "
One part cement, three parts standard sand.	
7 days (1 day in moist air, 6 days in water)	175 "
28 days (1 day in moist air, 27 days in water)	250 "

The cement shall not contain more than 1.75 per centum of anhydrous sulphuric acid, nor more than 4 per centum of magnesia.

The tests shall be made in accordance with the methods proposed by the Special Committee on Uniform Tests of Cement of the American Society of Civil Engineers.

Tests of cement used in building operations shall be made from time to time under the supervision of the Superintendent of Buildings, in accordance with the preceding specifications. All Portland cements meeting the above requirements shall be approved but the Superintendent of Buildings shall reject or disapprove the cement failing to meet any of the above requirements. A record of the cements which shall meet the requirements of this section and of these specifications, shall be kept in the Bureau of Buildings for the public's information. A representative of the manufacturer may be present at the making of the tests and in case of failure, the Superintendent may, at the request of the manufacturer, order the tests repeated at some recognized testing laboratory in the manner above specified. All expenses of such tests to be paid by the manufacturer, or the user, and the same samples are to be used in these tests as were used in the previous tests. No brand of cement, which has not been tested under the provisions of this section, or which has not met the requirements, shall be used in building operations.

CEMENT MORTAR: Cement mortar shall be made of Port-

The Academy of Sciences Building

San Francisco, Cal.

After the Earthquake and Fire. Reinforced concrete floors and light cast iron columns filled with concrete. Built about 1890
Note damaged of brick walls and excellent state of the concrete floors

land cement and sand in the proportion of 1 part cement and not more than 3 parts of sand by volume and shall be used immediately after being thoroughly mixed. All materials shall be measured; 3.8 cubic feet shall be considered a barrel and 4 bags of cement of 95 pounds each shall be considered one barrel. The sand and cement are to be thoroughly mixed before adding water.

SECTION 49. CONCRETE: All concrete shall be made of at least one part Portland cement and not more than two parts sand and five parts broken stone or gravel.

The cement and sand shall be of a quality prescribed in Sections 47 and 45 respectively.

The crushed stone shall be granite, trap rock or equally hard stone approved by the Superintendent of Buildings and shall consist of the run of the crusher graded from the larger size down to that retained on the one quarter inch screen. Where gravel is used it shall be thoroughly washed clean and well graded from the larger permissible size down to that retained on the one quarter inch screen.

For foundations, where the concrete is to be used in mass, the stone or gravel may be of such size as will pass a two inch ring.

For reinforced concrete construction, the stone or gravel must all pass through a three-quarter inch ring.

The water shall be clean and free from acid or strong alkalies.

All materials shall be measured; 3.8 cubic feet shall be considered as the contents of a barrel and 4 bags of cement of 95 pounds each shall be considered one barrel.

The ingredients of concrete shall be so thoroughly mixed that the cement shall be uniformly distributed through the mass and that the resulting concrete will be homogenous.

The concrete shall be mixed as wet as possible without causing a separation of the cement mortar from the mixture,

and shall be deposited in the work in such a manner as not to cause a separation of the mortar from the stone or gravel.

The concrete shall be placed in the forms as soon as practical after mixing and in no case shall concrete be used that has partially set or if more than one half hour has elapsed since the addition of its water.

It shall be deposited in horizontal layers not to exceed 8 inches in thickness and thoroughly tamped.

All forms and centering shall be built plumb and to true lines in a substantial manner and with joints sufficiently tight to prevent the leakage of the concrete. They shall be properly supported and braced in such a manner as to safely stand both the dead load and the load that may be placed upon them during construction. Before placing the concrete the forms shall be thoroughly cleaned of all chips, shavings and other debris.

Before the placing of concrete is suspended, the joint to be formed shall be made in such a manner as will not injure the strength of the completed structure.

Whenever fresh concrete joins concrete which has set or partially set, the surface of the old concrete shall be roughened, cleaned and thoroughly wetted with water and spread with a mortar consisting of one part cement and two parts sand.

Concrete shall not be mixed or deposited at a temperature lower than 28 degrees F., unless precautions are taken to avoid the use of materials covered with ice or snow, containing frost or that are in any other way unfit, and that further precautions are taken to prevent the concrete from freezing after being placed in position.

The time at which props or shores may be safely removed from floors or roofs will vary with the condition of the weather but in no case should they be removed until the hardening of the concrete has proceeded to a point where they may be removed with safety.

Academy of Sciences Building
San Francisco, Cal.
After the Earthquake and Fire. Reinforced concrete floors and light cast iron columns filled with concrete
Note the cantilever and general excellent condition of the floor structure. 25′ 0″ spans

In no case shall the vertical props or shores be removed from under floors or roofs before the expiration of ten days from the completion of the tamping of the concrete. The side forms where conditions permit may be removed in 4 days.

During extreme hot dry weather, especial precautions should be taken to prevent premature drying by keeping the concrete moist until it has attained its initial set, or at least during the first 24 hours.

SECTION 53 : CONCRETE.

Compression.

Direct.

Portland Cement, one part ; sand, two parts ; stone, four parts ; 500 pounds.

Portland Cement, one part ; sand, two parts ; stone, five parts ; 400 pounds.

Cross Bending.

Portland Cement, one part ; sand, two parts ; stone, four parts ; 700 pounds.

Portland Cement, one part ; sand, two parts ; stone, five parts ; 600 pounds.

The working stresses given in the code for natural cement are entirely too high, and it would seem proper, further, to eliminate entirely the use of natural cement for buildings ; therefore, no working stresses have been given. The reason for such a recommendation is, that natural cement requires considerable time to acquire any considerable degree of strength, is usually quick setting, and, as a whole, not desirable to use ; in the case of a reinforced concrete building, should not be used under any circumstance. By having two grades of cement it is possible that there may be cases where a natural cement would be used through ignorance of the workmen where Portland Cement is required. It is, therefore, desirable to eliminate this class of material ; and, further, for the reason that Portland Cement is nearly as cheap, in the proportions in which it is used, as Rosendale ; and for equal strengths this cheapness is in favor of Portland Cement.

Under section 54, would recommend the striking out of the figures under the head of "Safe Extreme Fibre Stresses." The working stresses given in other sections are sufficient, while the fibre stresses given for Portland Cement are entirely too low, and besides, the code should contain only those figures which are generally used.

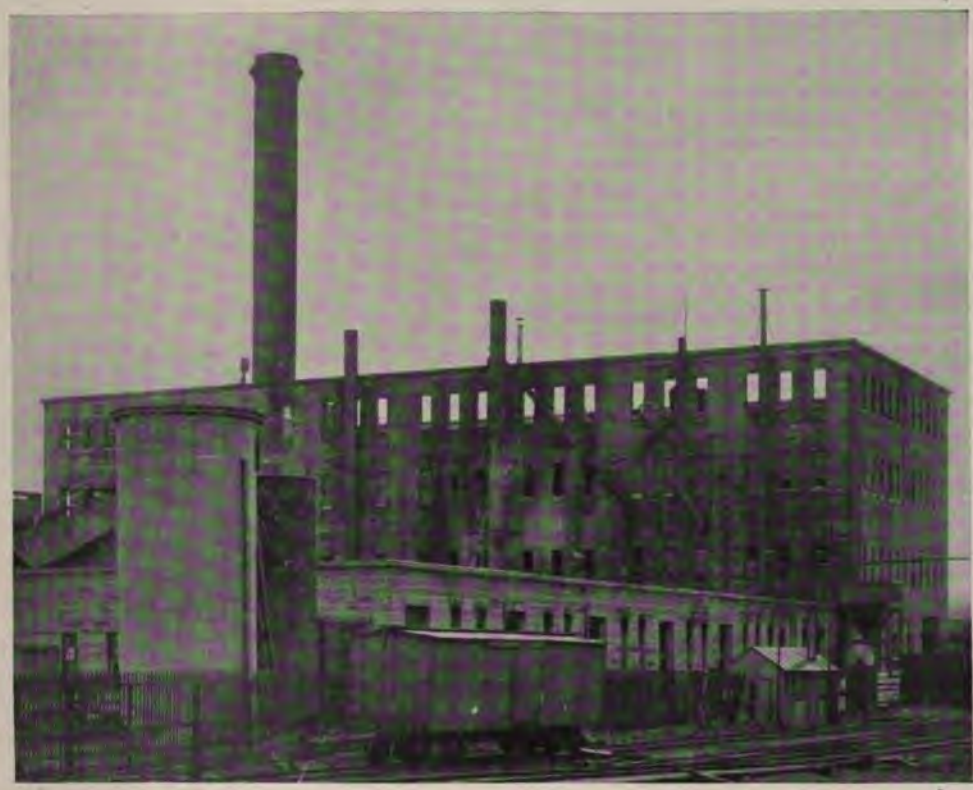
SECTION 62: In the second line the word "steel" should be omitted before "frame"; the sentence thus amended to read, "The dead loads in all buildings shall consist of the actual weight of the walls, framing, floors, roofs, partitions, and all permanent construction." The intent of this clause is evidently general and it should, therefore, include all kinds of framing which are permissible under the code. The use of the word steel is, therefore, restrictive and unnecessary.

SECTION 110: All stairways in fireproof buildings should be constructed of either reinforced concrete or the steel horses or supports should be fireproofed. There is a general practice to construct stairways in fireproof buildings using cast-iron frame-work with marble or slate treads.

The conflagrations of Baltimore and San Francisco have demonstrated the folly of this practice and the failure of the marble and slate treads through calcination, and of the cast iron under the action of heat, was most general. In fact, the writer in San Francisco did not see a single stairway in any building in which there had been any considerable degree of heat which was not wholly or partially wrecked

SECTION 111: This section is unnessarily restrictive in its present wording, because it implies that fireproof floors should be constructed of steel floor beams. It is a well established fact that floors of reinforced concrete have by all odds the best record for their fire-resistive qualities. The low conductivity of concrete renders it particularly adaptable for fireproofing purposes, and it seems to the writer that there should be a tendency to rather favor this class of construction. The suggestion is therefore made that this section be worded to read as follows: "Fireproof floors and roofs shall be constructed of reinforced concrete as provided in section 117 of this code, or with steel floor beams

Pacific Borax Company's Plant,
Bayonne, N. J.
General view showing total collapse of structural steel shed, and the practically undamaged reinforced concrete structure in background



Pacific Borax Company's Plant
Bayonne, N. J.
General view showing four story reinforced concrete building, collapsed steel shed, and the walls of single story reinforced concrete annex. The latter also has a wooden roof

spaced not more than five feet on the centers for class E buildings, and for all other buildings except such as are otherwise provided for in this code, not more than eight feet on centers.

In section 112 there should unquestionably be a provision for reinforced concrete as a first-class fireproofing material. There is no better material in the world for use in fireproof buildings than concrete for the reason already stated as to its fire-resistive qualities, and further, for the reason it is a plastic material until hardened it can be applied to far better advantage than any other material.

There is a fallacy prevalent that concrete, being a fireproofing material, requires no protection against fire when it is used for structural purposes. There is no material which is absolutely fireproof, it being simply a question of the degree and duration of the heat as to whether or not the best building materials succumb. While concrete suffers less than most building materials and is among one of the best materials of this type, it is, nevertheless, a fact that it is injured by heat. The peculiar advantage, however, is that concrete, even though the water of crystalization has been driven off to a greater or lesser extent in an intensely hot fire, still remains in place and affords, therefore, the same protection to the material which it encases as it did at the beginning of the fire.

It, therefore, necessarily follows that when concrete is used as a structural material an additional thickness of concrete is necessary for fireproofing purposes.

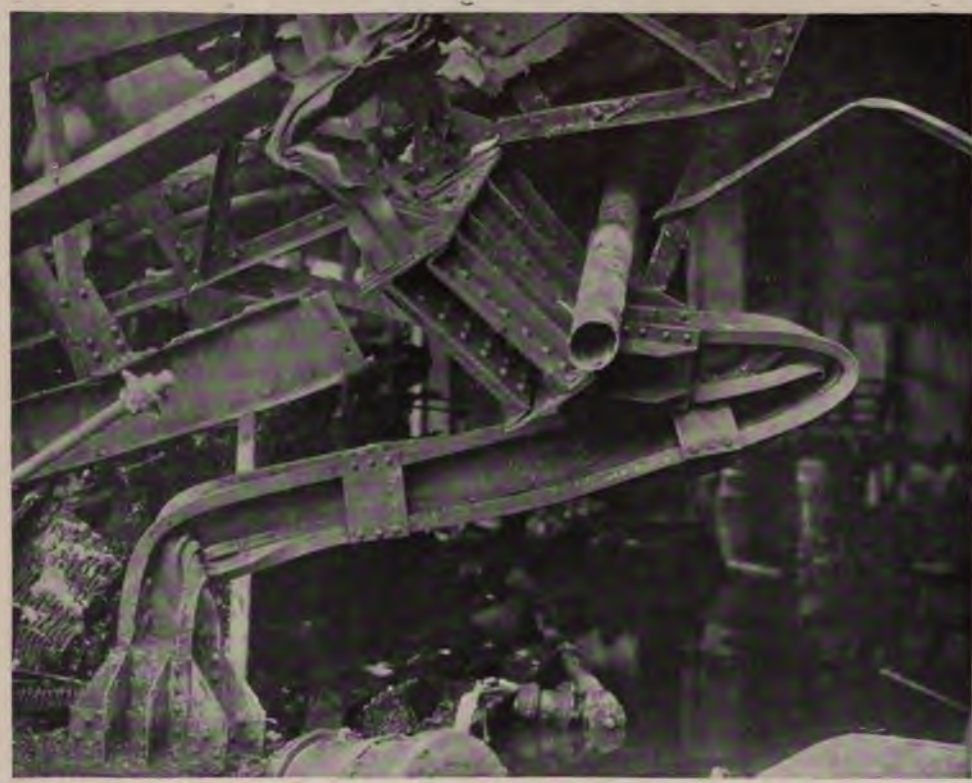
Reinforced concrete should, therefore, be placed in first-class construction, and should meet the same requirements as to the question of fireproofing as is required in the case of other materials included in this class. It is a fact that two inches of concrete is ample protection in an ordinary fire. It is also a fact that no greater protection should be required in the case of reinforced concrete than is required in the case of any other material, but, for the reason already stated, if there be any discrimination it should be in favor of a lesser thick-

ness. The suggestion is, therefore, made that there be incorporated in this section the following paragraph : " Where reinforced concrete is used as a structural member it should be fireproofed as is required of other structural materials, the thickness of the protective coating being the same as required by this section."

Another portion of this section which appears to be unjust is the part which requires that " * * * Reticulated or meshed steel or similar reinforcing material shall weigh not less than one pound per square foot of superficial floor area " ; and the further provision that, * * * " If in the form of mesh it shall have no openings smaller than sixteen square inches." This is an unnecessary restriction, and there can be no just reason for it. In the first place the amount of reinforcing metal to be used in a floor is regulated by the load which it is to carry and the working stresses allowed by the code. The size of the mesh is purely an arbitrary one, and certainly a mesh of three inches, or nine square inches in area is amply large to permit of three-quarter inch stone, which is the maximum size allowed in reinforced concrete construction, to pass through so as to thoroughly encase the metal. The suggestion is made, therefore, that this be reduced to at least nine square inches, and preferably to a two inch mesh, or four square inches. This applies equally to sections 112 and 113.

Concerning section 115 the writer desires to raise the question of the value of tests of fireproofing as commonly made, and thinks it may be taken as a fact that in most cases the first attempt in such a test results in failure, but that the second attempt results in a construction that satisfactorily passes the test. Generally these tests are made to apply only to reinforced concrete construction, and are not cases of structural steel fireproofed with either terracotta or other forms of fireproofing. The question of the ability of a structure to resist fire is one that is dependent on the

Pacific Borax Company's Plant
Bayonne, N. J.
Showing collapsed structural steel shed caused by buckling of steel work; an enlarged view of the column at point indicated by the arrow is shown in following view



Pacific Borax Company's Plant
Bayonne, N. J.
Enlarged view of collapsed steel column shown in previous view

materials used and good workmanship, and it by no means follows that where a test floor or panel is constructed for the particular purpose of passing the requirements of a test that a similar structure constructed under less critical conditions would yield the same results. On the contrary the writer believes it is a fair criticism to say that these tests are of little value in establishing the fire-resistive qualities of actual structures. It is a fact that the fire-resistive qualities of concrete have been sufficiently established, and if the requirements of this code are complied with as to the thickness of the protective coating it would be unnecessary to actually test it in order to establish its efficiency.

SECTION 117—REINFORCED CONCRETE: The second paragraph in this section should be amended to read, as follows: "Buildings of reinforced concrete, when designed in accordance with the requirements of this section, should be deemed fireproof and permissible under this code for the same buildings as first-class construction, as defined by section 112."

Amend the third paragraph to read, "Concrete shall be mixed in the proportion of one part Portland Cement, two parts sand, and four parts of aggregate (crushed stone or gravel) by volume; and amend the sixth paragraph so as to read, as follows: "The aggregate used in the concrete shall be a clean, broken stone or gravel, of a size that will pass through a three-quarter inch ring, and conforming in every respect to the requirements as set forth in section 49 of this code. In case it is desired to use any other material than that specified, samples of the same must be submitted to and be approved by the Superintendent of Buildings."

It is suggested that the paragraph fixing the working stresses for steel and concrete be amended to read, as follows: "Reinforced concrete shall be so designed that the stresses in the concrete and the steel shall not exceed the following limits:

	Pounds.
Concrete in direct compression shall have an extreme fibre stress per square inch	500
Concrete in compression, cross bending, per square inch	700
Concrete in shear, per square inch	75
Tensile strength in steel, per square inch, one-third of elastic limit, the allowable stress, however, not to exceed	16,000
Shear in steel, per square inch	10,000.

The paragraph relating to the thickness of the concrete outside of the reinforcement, in view of the requirements of section 112 providing for a definite thickness for fireproofing purposes, should be modified, and should be limited to one inch of protection in all cases. With the fireproofing on, the actual protection to the structural members will be considerably more than the values given in this section.

The section relating to the percentage of longitudinal reinforcement in columns should be modified since it evidently does not cover the intent of the requirement because the minimum percentage given, *i. e.*, one-half of one per cent. of the effective sectional area, would mean in the case of an eight inch column, which is the minimum section allowed, a total area of reinforcing metal equivalent to about three three-eighth inch rods. The suggestion is made, then, that this portion be changed so as to read, "All such columns shall have longitudinal reinforcement of a total cross sectional area equal to at least one per cent. of the effective sectional area of the concrete." In the following paragraph it is suggested that it be made to read: "Reinforced concrete columns may be stressed five hundred pounds per square inch of this effective area, with no allowance for the compressive strength of the vertical reinforcement."

The following paragraph should be amended to read as fol-

Pacific Borax Company's Plant
Bayonne, N. J.

View top floor. The roof was of wood, and was supported by wooden posts, which supported the steel tank shown. The destruction of this wooden roof by fire caused the collapse of this tank, which drove the machinery through the top floor, as showing in following view

Pacific Borax Company's Plant
Bayonne, N. J.
View of wider side of top floor, showing where collapse of steel tank drove machinery through floor slab. The fire on this floor resulting from the burning of a large quantity of circular matter, did practically no damage to the concrete.

lows: "In the case of circular columns, which are further reinforced by bands or spirally wound hoops, the allowable unit working stress in direct compression shall be 1,000 pounds per square inch of the effective sectional area of the concrete, provided the bands or hoops shall be designed to resist a lateral load equivalent to one-fifteenth of the vertical load carried by the concrete within the reinforcing cage, and shall not be stressed more than 16,000 pounds per square inch and provided further, that the bands or hoops shall not be spaced more than one-eighth of the diameter of the spiral."

The clause relating to construction in freezing weather shall be amended to conform with section 49, as follows: "No reinforced concrete construction shall be carried on in a temperature lower than 28° F., except as provided in section 49 of this code." With the restrictions placed on concrete construction in temperatures lower than 28° F. there can be no danger, and it should be perfectly permissible to carry on work under these conditions. Buildings are being successfully erected in different parts of the country where the temperature is constantly below the freezing point; the contractors, however, are obliged to provide artificial means of maintaining the temperature of the concrete above freezing.

Hedged in with ample requirements such as have been fixed in section 49 there can be no objection to allowing concrete construction to be carried on at all times.

ARGUMENT PRESENTED

BEFORE

COMMITTEE ON LIMITATION OF HEIGHT AND AREA

OF THE

COMMISSION FOR THE REVISION

OF THE

Building Code of New York

MARCH 6, 1908

BY

RICHARD L. HUMPHREY, M. AM. SOC. C. E.,
Secretary, National Advisory Board on Fuels and Structural Materials.

COMMITTEE.

CHARLES G. SMITH, *Chairman*, EDWARD F. CROKER,
THOMAS L. HAMILTON, PATRICK J. BYRNES,
CHARLES H. CULLEN.

MR. CHAIRMAN AND GENTLEMEN: The problems that present themselves in the consideration of the height to which buildings should be erected are probably among the most important to be considered in the preparation of a building code.

Mr. Flagg and the last speaker Mr. Babb have pointed these out to you at considerable length and I shall not therefore dwell particularly on this phase of the question.

I would like to call your attention to the fact that a building of any kind whether it be of the so called "fire proof type" or not should be like a fortress capable of resisting attacks from without and especially capable of resisting attacks from within.

This is particularly necessary where the height of the building is so great that the fire department would be unable to cope with a fire in its upper part.

Buildings of unusual height should be provided with special appliances for fighting fire independent of the regular City fire service.

I believe the word "fire-proof" should be eliminated in describing buildings since it gives a false sense of security and leads to a neglect of those precautions absolutely necessary to guard against fire both from without and from within the building.

The structural parts of a building may be properly fire proofed yet the exterior exposures may be so bad that a fire can enter through such openings.

A building may be properly fire proofed with exterior openings protected with fire shutters, wire glass windows, with metal frames and sash and other protective devices and should these openings be left open a condition arises which may result in a fire.

The main provisions of the fire proofing clauses of the code should require such thorough protection of all openings and exterior exposures as to minimize the danger of fire from without, especially in high structures.

In illustration of this point I would call your attention to the San Francisco fire, where a large number of moderately "fire proof" buildings were destroyed by reason of the fact that they were surrounded by a great many low buildings of the combustible type, frame construction, which set fire to these so-called "fire proofs" through the unprotected openings.

A building should be just as high as the facilities of the fire department will permit with safety.

It is surely a fact that these great buildings now being erected in New York are a menace to public safety, even though the fire should occur in the lower floors accessible to the fire department. The people in the upper stories of such a building would be in danger in event of a fire in the lower stories should the failure of the fire proofing be accompanied by a buckling of the columns, resulting in a settlement of 10 or 12 inches, as is frequently the case.

What would be the effect of such action in a structure 40 stories high?

A building should be required to have proper protection for its exterior exposures; so as to resist the action of fire in surrounding structures. And should the requirements of the new code for fireproofing be adequate, as I presume they will be, then the height to which buildings should be erected within reasonable limits is not so serious, if the structure is provided, also with independent facilities for fighting fire.

There is one restriction in this proposed code, however, which I want to dwell upon particularly.

That is the arbitrary restriction upon the height to which a reinforced concrete building may be erected.

The code proposed by the former commission states that the height of a building of this type shall not exceed 85 feet.

The question of the height to which a building may be erected is manifestly dependent entirely upon the design, which is governed by the allowable

Masonic Temple Building
Chicago, Ill.
Showing failure of the terra cotta tile floor arches subjected to fire

working stresses fixed by the code for the various classes of materials, and which are considered with due regard for the commercial necessities.

There should be no discrimination as to the height of a reinforced concrete structure. If this discrimination is due to the feeling that such structures are not safe, then I would refer you to the structures of this type which have been successfully erected in many parts of this country, considerably exceeding 85 feet in height, and further, to the behavior of reinforced concrete structures in a conflagration, as proof of the safety of such structures under such conditions.

I would like to submit for your consideration as a part of this brief a partial list of reinforced concrete buildings exceeding 85 feet in height, ranging from 8 to 16 stories.

These structures demonstrate the fact that they are perfectly safe, have a far greater resistance to fire than other structure and are more economical.

I believe it is desirable to limit the height of all buildings, such limitation should not however discriminate against any of the materials permissible in first class construction.

The proper height for buildings is governed by questions of light, ventilation and possible dangers in case of fire.

The matter of limiting the height of a reinforced concrete building received the attention of the former Commission, and I presume will be a matter for consideration by the present Commission.

In summarizing the facts bearing on reinforced concrete, I would direct your attention to three points :

First. The height is regulated by the design governed by the working stresses given in the Code.

Second. The material being of first class fire proofing quality is peculiarly fitted for use in tall structures.

Third. The cheapness of the material, coupled with its great fire-resistive qualities, makes it possible to erect econ-

omical structures on which can be secured the lowest rates of insurance.

No building should be higher than a point beyond which the fire department is able to cope with a fire in its upper portions; and where higher structures are erected, the law should compel them to be equipped with adequate facilities for fighting fire.

I believe on the broad proposition no structure of first-class construction should be higher than 150 feet. The word "fireproof" should be eliminated from the Code as it engenders a false feeling of security and leads to neglect of the ordinary precautions to be taken against fire. Buildings should be designated as of first or second class construction.

I think that perhaps in the case of a mercantile building which contains an immense stock of inflammable material there should be an even greater restriction in height than in the case of an office building, and this height should be less than 150 feet.

Although it should be borne in mind, as has been pointed out by Mr. Babb, that the feeling, that an office building contains less inflammable material than a mercantile building and that the fire risk is less, is fallaceous.

There is enough inflammable material stored in an office building to generate in case of case a heat sufficient to damage such a structure to great extent.

I think this was demonstrated in San Francisco, where a number of buildings contained material in shape of letter files, pamphlets, books, etc., which generated sufficient heat to destroy the fireproofing and damage the structural skeleton.

Whatever your Commission may decide I trust it will not discriminate against concrete, which is one of the best materials adapted for structural and fireproofing purposes; a more extended use of which will add materially to public safety.

11th Floor Granite Building
Rochester, N. Y.
Showing complete failure of terra cotta floor tile

LIST OF

REINFORCED CONCRETE BUILDING, 85 FEET AND OVER IN HEIGHT, SUBMITTED

By

RICHARD L. HUMPHREY, M. Am. Soc. C. E.

Some of the More Important Reinforced Concrete Buildings in Various Cities of the United States, 85 Feet and Over in Height.

GREATER NEW YORK.

Cavanagh Building, 7 stories, 89 feet, 50 x 100 feet.
Colgate Building, 8 stories, 92 feet, 86 x 208 feet.
McGraw Building, 11 stories, 159 feet, 126 x 90 feet.
McNulty Building, 10 stories, 125 feet, 50 x 90 feet.
Monolith Building, 12 stories, 150 feet, 50 x 200 feet.
Rodgers & Pyatt Building, 10 stories, 125 feet, 63 x 60 feet.
Eastman Kodak Co. Building, 8 stories, 108 feet 6 inches, 99 x 60 feet.
Isaac Mason Warehouse, 7 stories, 87 feet, 80 x 40 feet.
C. Kenyon Co., 6 stories, 84 feet 5 inches, 145 x 80 feet.
Bush Terminal, 6 stories, 84 feet 9 inches, 600 x 75 feet.
Warehouse Thonet Bros., 7 stories, 89 feet 9 inches, 75 x 95 feet.
Great Atlantic & Pacific Tea Co., 9 stories, 119 feet 6 inches, 179 x 121 feet.
Factory Robert Gair No. 1, 9 stories, 111 feet 10 inches.
Factory Robert Gair No. 2, 10 stories, 124 feet, 231 x 200 feet.
Factory Keuffel & Esser, 6 stories, 100 feet 9 inches, 200 x 100 feet.
Automobile Club of America, 8 stories, 100 feet, 100 x 100 feet.
Mergenthaler Linotype Co., 9 stories, 135 feet, 80 x 174 feet.
Thompson & Norris, 8 stories, 90 feet, 80 x 110 feet.
Bowling Green Storage Wharehouse, 7 stories, 90 feet, 50 x 95 feet.
Commercial Trust Company.
Packer Garage.
Siegel Color Works, 6 stories, 85 feet, 100 x 200 feet.
Schwartzchild and Sultzberger.
Hygenic Ice Co.
Eagle Warehouse, 7 stories, 90 feet, 63 x 90 feet.
Long Island College Hospital, 89 feet.
Bronx Church House, 86 feet.

DETROIT, MICHIGAN.

Trussed Concrete Building, 9 Stories, 110 ft., 48 x 120 ft.
Tuller Apartments, 10 stories, 105 ft., 100 x 125 ft.
Solvay Process Co. (Coal Bins).
Booth Cold Storage Co.

CHICACO, ILLINOIS.

Manufacturers' Furniture Exchange, 8 stories, 70 x 170 ft., 111 ft. high.
Montgomery Ward Building, 8 Stories, 270 x 731 ft., 135 ft. high with a 20-story tower.
Libby, McNeal & Libby, Building,
Planadon Building, 8 stories, 100 ft., 50 x 80 ft.

PHILADELPHIA, PENNSYLVANIA.

Ketterlinus Lithographic Manufacturing Co., 8 stories, 68 x 80 ft., 116 ft. high.
Boyertown Burial Casket Co., 6 Stories, 69 x 85 ft., 90 ft. high.
Smith, Kline & French Company, 6 Stories, 61 x 90, 84 ft., 6 in. high.
Locust Realty Company, 5 stories, 117 x 199 ft., 85 ft. high.
Grellet, Collins Bldg., 8 Stories, 115 ft., 110 x 99 ft.

ST. LOUIS, MISSOURI.

Ely, Walker Dry Goods Co., 8 Stories, 150 x 150 ft.
Dulaney Realty Co., 8 Stories, 60 x 133 ft.
Nacaire Realty & Investment Co., 50 x 130 ft., 7 Stories.
Butler Bros. Building, 8 Stories, 280 x 324 ft., 113 ft. high.
Leson & Gould, 8 stories, 50 x 150, 120 ft. high.

TROY, NEW YORK.

Office Building, 7 Stories, 86 ft.

MINNEAPOLIS, MINNESOTA.

Forman-Ford Building,
Lindeke-Waner, 7 Stories, 165 x 250 ft.
Farwell, Ozmun & Co., 9 Stories, 110 ft., 170 x 290 ft.
Minneapolis Paper Company Warehouse,
Armory,

Annex United States Fidelity and Guaranty Company's Building
Baltimore, Md.

Demonstrating excellent fire resisting qualities of reinforced concrete. Floors and columns of reinforced concrete, front of cast iron, walls of brick. Note floors left unsupported through the crumbling of the brick walls

ST. PAUL, MINNESOTA.

Nicol, Dean & Gregg Warehouse,
Ham Brewery, 8 stories, 140 ft.
Hackett, Walther Gates & Co.,
Patterson Building,
Parsons-Scoville Building,

PITTSBURG, PENNSYLVANIA.

Bernard Gloekler Co., 10 stories, 80 x 100 ft., 146 ft. high.
Pennsylvania Chocolate Co., 6 stories, 69 x 85 ft., 90 ft high.
Century Building, 13 stories, 180 ft., 60 x 110 ft.

CINCINNATI, OHIO.

Merkel Bros., 7 stories, 100 ft.
Ingalls Building, 16 stories, 50 x 100 ft., 210 ft. high.
Roch Building, 10 stories, 60 x 80 ft.
L. Stix & Co., 7 stories, 101.5 ft.
American Oak Leather Company, 6 stories, 90 feet.
Rauh & Mack Shirt Company, 8 Stories, 122 ft. 4 In.
Day & Night Tobacco Co., 7 Stories, 108 Ft. 6 In.
Fireproof Storage Co., 6 Stories, 90.5 feet.
Charles Moser Co., 7 Stories, 96 ft.
Merchants Ice & Storage Co.,
Reins & Meiss, 8 Stories, 107 Ft. high, 70 x 108 ft.
Samuel Ach & Co., 7 Stories, 88 ft. high. 70 x 108 ft.

ATLANTIC CITY, NEW JERSEY.

Hotel Traymore, 10-14 Stories, 60-200 x 560 ft.
Marlborough-Blenheim, 10-13 Stories, 76 x 122 ft.

BALTIMORE, MARYLAND.

Baltimore Evening News Building, 7 Stories, 58 x 74 ft. 104 ft. high.
Marlborough Apartments, 10 stories, 161 x 129 ft., 121 ft 5 in. high.
Warehouse, 96 ft.

LANCASTER, PENNSYLVANIA.

Moss Cigar Co.

CHARLESTOWN, W. VA.

Kanawha Hotel,
Charlestown National Bank, 7 stories, 100 ft. high, 52 x 117 ft.

ANNAPOLIS, MARYLAND.

U. S. Military Academy, 130 x 130 ft. 142 ft. 5 in. high.

SPRINGFIELD, MASS.

Phelps Publishing Co., Building, 125 ft.

SYRACUSE, NEW YORK.

Brown Lype Gear Co.

GRAND RAPIDS, MICHIGAN.

Sicketee Building.

INDIANAPOLIS, INDIANA.

Board of Trade Building.

TORONTO, CANADA.

Wilson Warehouse, 7 stories, 85 ft. 55 x 190 ft.
A. A. Allen.

LIMA, OHIO.

Lima Locomotive Works Office Building

NEWARK, OHIO.

National National Bank

HOUSTON, TEXAS.

Southern Office Building, 5 stories, 114 ft. 50 x 140 ft.

Annex United States Fidelity and Guaranty Co. Building
Baltimore, Md.

Showing excellent condition of reinforced concrete floor and columns after being subjected to a very hot fire

LOS ANGELES, CALIFORNIA.

Heyward Hotel.

WINNIPEG, CAN.

Aikens Building.

MOBILE, ALABAMA.

Van Antwerp Building, 10 stories, 108 ft.

BRIDWELL, MO.

State House of Correction, 87 ft.

ALLEGHENY, PA.

Allegheny Station, 86 ft. Tower, 130 ft.

LOUISVILLE KY.

Belknap Warehouse, 9 stories, 175 x 200 ft.
Stewart Dry Goods Co., 7 stories, 108 x 180 ft.

LYNN, MASS.

Lynn Storage Wasehouse, 50 x 165, 85 ft. high.

MILWAUKEE, WIS.

Caswell Block.
Ziegler Building.
Hoffman Building.
Kuehn Building.

GREEN BAY, WIS.

Minahan Building.

SAN DIEGO, CAL.

U. S. Grant Hotel, 7 stories wings, central portion 9 stories, 200 x 200 feet.
John D. Spreckels Building, 6 stories, 85 x 150 ft.

SEATTLE, WASH.

Majestic Building, 12 Stories, 135 ft.
Perry Apartments, 9 stories, 105 ft. 115 x 120 ft.
Waldorf Apartments, 8 stories, 90 ft. 110 x 120 ft.

DENVER, COLO.

Ideal Building, 9 Stories, 50 x 125, 100 ft. high.

TOLEDO, O.

Bostwick Brown Building,

MARIETTA, O.

German National Bank, 9 stories, 105 Ft. 30 x 100 ft.

ALBANY, N. Y.

Hampton Hotel, 8 stories, 98 ft.
Homeopathic Hospital, 7 stories, 92 ft.

WASHINGTON, D. C.

Karick Warehouse.

WICHITA, KAN.

Smythe Building,

NORFOLK, VA.

Lynn Haven Hotel, 8 stories,
Botetort Apartments.
Y. M. C. A. Building, 88 ft.

CLEVELAND, OHIO.

M. A. Bradley Building,
Sheriff Street Market Building, 8 stories, 88 ft. 100 x 113 ft.

YOUNGSTOWN, OHIO.

American Building, 86 ft. 11 in. high,
Century Building, 8 stories.

Commercial and Farmers' National Bank Building
Baltimore, Md.

A striking illustration of the value of concrete for fireproofing purposes. Upper stories and roof non-fireproof entirely destroyed. Bank floor fireproofed, but not damaged by fire or by impact of falling floors.

SAN FRANCISCO, CAL.

(This list covers all heights. It is given in full to show the extent to which concrete has been used in the reconstruction of San Francisco.)

* American Biscuit Co., 5 stories.
* Adams Building, 5 stories.
American Chocolate Co., 3 stories.
Anglo-California Bank, 4 stories.
Anderson Building, 2 stories.
* Bradenstein Building, 6 stories.
Backus Building, 2 stories.
Balis Building, 3 stories.
Bernard Building, 3 stories.
* Boyd Building, 8 stories.
Bryntson Building, 4 stories.
* Bemis Bros. Bag Company, 6 stories.
* Bothin Building, 6 stories.
* Brown Building, 7 stories.
Baer Building, 4 stories.
* Barron Estate Co., 7 stories.
* Carpy Building, 5 stories.
* Clarke Building, 5 stories.
* Century Investment Company, 6 stories.
* Drexler Building, 7 stories.
* Darrow Building, 6 stories.
Denman Building, 2 stories.
Del Monte Mills, 2 and 3 stories.
Freeborn Building, 3 stories.
Folger Building, 3 stories.
Galleazzi Building, 3 stories.
Huber Building, 2 stories.
* Hazlett Building, 8 stories.
Hooker Estate Building, 4 stories.
Halsey Building, 4 stories.
* Hopkins Building, 7 stories.
Jennings Building, 3 stories.

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* Over 85 ft.

Jorgensen Building, 3 stories.
* Langley & Michaels Building, 8 stories.
* Lagalette Building, 6 stories.
Land Wharton Building, 3 stories.
Lietz Building, 4 stories.
Lowenberg, 3 stories.
* Latham Building, 6 stories.
* Marvin Building, 7 stories.
* Mac Donough Estate Building, 7 stories, 101 ft., 86 x 38 ft.
* " " Building, 2 stories.
Martin Estate Building, 3 stories.
Mission Savings Bank, 2 stories.
McCone Building, 2 stories.
Nunziatto Building, 2 stories.
* Owens & Unger, 6 stories.
Peizer Building, 3 stories.
* Pacific Company Building, 9 stories.
* Phelan Building, 12 stories.
* Pond Building, 5 stories.
Pacific Building, 4 stories.
* Rosenstein Building, 10 stories.
* Santa Martin Building, 8 stories.
* Sheldon Building, 8 stories, 92 x 137 ft.
Scatena Building, 3 stories.
Schweitzer & Bauer Building, 3 stories.
* Swett Company Building, 5 stories.
Schiff Building, 3 stories.
Shaefer Building, 4 stories.
Shelling Building, 3 stories.
* Viavi Building, 5 stories.
Voorman Building, 3 stories.
* Voorhies Building, 7 stories.
* Wilson Building, 7 stories.
* West Bank Building, 8 stories.
Wellman-Peck Building, 3 stories.
Western Meat Company, 2 stories.

---

* Over 85 ft.

Commercial and Farmers' National Bank
Baltimore, Md.

Showing complete failure of non-fireproof portion. Note partition of reinforced concrete still standing in center

ARGUMENT

By

ROSS F. TUCKER, M. Am. Soc. C. E.,

President of the Concrete Association of America.

GENTLEMEN: On behalf of the Concrete Association of America, and also on behalf of the Masters' League of Cement Workers, I have the honor to present to you the following memorandum in respect to that part of the proposed Building Code relating to the design and regulations governing concrete and reinforced concrete structures. I would like to add here that what I have to say in respect to these regulations is based on some fifteen years' experience in the introduction and development of concrete as a building material, and the rules outlined are based upon my personal experience in the execution of more than a thousand undertakings in all departments of engineering and architectural construction, including a considerable number of the principal structures cited in the following lists. Permit me to call your attention to the fact that there exist in and around New York more than sixty important buildings built of reinforced concrete. A list of the larger of these structures is annexed hereto.

Name of Building.	No. of Stories.
McNulty Building	10 Stories
McGraw Building	11 Stories
Monolith Building	12 Stories
Mergenthaler Linotype Building	8 Stories
Kodak Building	8 Stories
Automobile Club	8 Stories
Storage Warehouse	7 Stories
Robt. Gair Factory	9 Stories
Great. Atl. & Pacific Tea Co	9 Stories
Bush Warehouses	7 Stories
Bush Factory, No. 1	7 Stories
Bush Factory, No. 2	6 Stories
Bush Factory, No. 3	6 Stories
Thonet Warehouse	7 Stories
Gretsch Factory	6 Stories
Cavanaugh Factory No. 1	6 Stories
Cavanaugh Factory No. 2	7 Stories
Lawrence Building	8 Stories
Apartment House	9 Stories
Siegel Color Work	4 Stories
Goelet Garage	7 Stories
Office Building	7 Stories
Thompson & Norris Building	8 Stories
Hanan Shoe Factory	6 Stories
Keuffel Esser Factory	6 Stories
Seely Factory	5 Stories
Mason Warehouse	7 Stories
Kenyon Factory	6 Stories
Mill Buildings	5 Stories
Rubber Factory	5 Stories
Colgate Factory	8 Stories
McClure Factory	4 Stories
Varnish Factory	4 Stories
Schirmer Factory	5 Stories
Cold Storage Plant	5 Stories
Garage	4 Stories
Garage	5 Stories
Garage	4 Stories
Club House	5 Stories
Stable	4 Stories
Residence	4 Stories
Residence	4 Stories
Warehouse	5 Stories
Factory	4 Stories
Warehouse	4 Stories
Warehouse & Factory	3 Stories
Museum Building	3 Stories
Car Storage Building	1 Story
Paper Mill	2 Stories
Chocolate Factory	2 Stories
Keller School	7 Stories
Robbins Garage	4 Stories
Chemical Works	1 Story
Rogers & Pyatt	10 Stories
Hergert Bldg	8 Stories
Hollender Bldg	5 Stories
Eagle Storage Warehouse	7 Stories
Boldt Garage	8 Stories
Matheson Garage	6 Stories
National Meter Co	4 Stories
Palace Garage	5 Stories
Tungston Lamp Factory	3 Stories
Laundry	3 Stories
Factory	3 Stories

10-story Reinforced Concrete Loft and Storage Building
McNulty Bros.
52d St. and 11th Ave., Manhattan

Reinforced Concrete Warehouse
Great Atlantic and Pacific Tea Co., Jersey City

You will note from an inspection of this list,

(a) That many of them are buildings of the largest size.

(b) That a great many of them are over 85′ in height.

(c) That almost all of them are entirely within the classification from which they were barred in the code prepared by the former commission.

(d) That nearly all of them are filled with the heaviest of merchandise and machinery.

(e) That many of them are filled with material of the most inflammable kind, such as paint, varnish, paper, furniture, etc.

(f) That they represent an investment of millions of dollars.

(g) That no accidents have occurred in the construction of any of them and that the technical requirements have been fulfilled, as witnessed by the fact that they are meeting in a most successful and efficient manner all of the purposes for which they were designed.

(h) That the list of owners, architects and engineers embrace names of the highest standing.

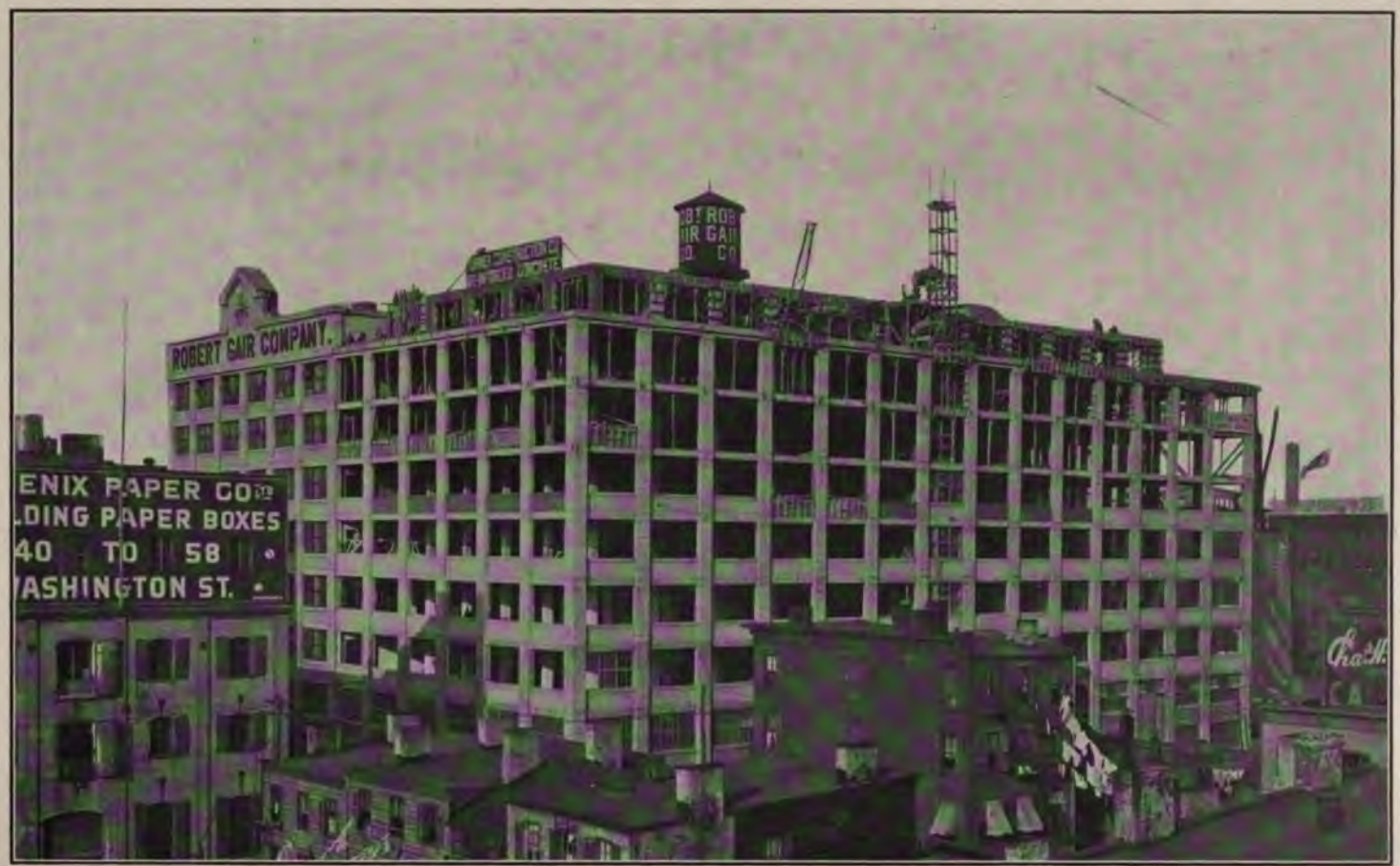
These buildings speak for themselves and are an eloquent argument on behalf of this type of construction. We believe that these structures are without question the most nearly fireproof of any type of building in the community, and that they go far toward proving the declaration recently made in the New York "Herald" by Professor W. H. Burr, Professor of Civil Engineering in Columbia University and Consulting Engineer of the Panama Canal, as follows :

Opinion of Professor Burr.

"The practically new combined structural material, concrete-steel, is, as a matter of fact, not yet fully introduced. Although it has highly valuable qualities for a wide and constantly extending range of such structures as bridges, dams, various public works, heavy and light building construction, docks, and many other classes of great works, the more timorous and less progressive parts of the community are not yet convinced of its demonstrated merits. There is every reason to believe that the substantial improvements now constantly being made in the quality and economy of manufacture of cement both in America and Europe, together with the rapid material advances being attained in the handling and fabrication of concrete-steel for a constantly widening range of purpose, indicate with certainty that the future will disclose a field of application of this structural material extended even far beyond the anticipations of its present advocates. It has already been applied to tall office buildings, and there is practically no limit to its possible use in this direction. For stiffness and strength as well as fire and earthquake-resisting qualities and in general durability, it has no successful competitor, nor is any in sight."

The following letter from John Steven Sewell, late Major, Corps of Engineers, United States Army, in reply to the writer's request for his views on the subject, is of great interest and value, because of the fact that Major Sewell has made a special study of reinforced concrete, and is recognized throughout the United States as a structural engineer of the highest attainments:

Cavanaugh Building
Hope Street, Brooklyn



Reinforced Concrete Factory Building
Robert Gair Company
Front St., Brooklyn

OPINION OF MAJOR J. S. SEWELL.

"In reply to your letter of April 6th, 1908, I have to say that, in my judgment, after a careful study of the subject from a purely professional point of view for many years, there is no doubt whatever that reinforced concrete can be made fully equivalent to structural steel for load carrying purposes, and, more than this, can be made to resist fire at least as well, if not better, than good types of commercial steel frame structures with terra cotta protection, such as that in common use, and approved by building departments.

At the same time, as you know, there are many so-called engineers and contractors engaged in reinforced concrete work, or in exploiting various forms of patented systems who do not take the precautions needed to make reinforced concrete what it ought to be. It would be a simple matter, however, for building laws to guard against ignorance or charlatanism in this as well as in other kinds of structural work, and I believe the time has come when, under proper restrictions, the reinforced concrete building should be recognized on an equal footing with the steel frame building fireproofed.

My personal opinion is that reinforced concrete columns should be designed and built as structural units, then covered with drums or slabs of reinforced cinder or brick concrete built up on metal lath, and securely applied to the column after it has set. This would avoid the danger of expansion cracks penetrating the structural part of the column, and would make repairs of the fireproof covering easier, after a fire. I think, as far as possible, we should avoid having structural stresses and expansion stresses due to fire, coexistent in the same material.

When it comes to girders, beams and slabs, of the floor systems, we have material under transverse stress, and conditions which make it well nigh impossible to apply a fireproof covering separate from the material doing structural duty. However, it is possible, by a proper design of the reinforcement, to

render unnecessary the performance of any structural duty by the concrete below the neutral axis, except the very moderate one of resisting compressive web stresses, which it will do perfectly well, even after it is seriously damaged by fire. To accomplish this, it is necessary to use a reinforcement in which web members are provided, rigidly attached to the main bars so as to transmit into the main bars the full stresses in the web members, without any assistance whatever from the concrete. The web members must vary in number or weight, according to the variation in the web stresses, and they must extend, entirely to the top of the beam, so as to be fully anchored in the compressed concrete above the neutral axis. If this is done, the concrete below the neutral axis may be seriously damaged in a fire, and may even spall off so as to expose the main bars, without danger of collapse. Moreover, the damaged concrete may be knocked off and replaced with fresh; the new and old materials will not bond with each other, but if the new material is simply secured against falling off by its own weight, as by causing it to completely surround the main bars,—the strength of the beam will be restored, since the compressive web stresses are not dependent upon a bond between the new and old materials for their successful transmission. If, however, attached web members designed as above described, are not used, the strength of the beam is dependent upon the ability of the concrete to transmit the stresses into the main bars or to bind the main bars and web members together. This involves serious tensile and shearing stresses in the concrete,—a duty that should not be expected of any concrete, however good, much less of a composite mass of old and new material without any bond between them. In my judgment, if the web stresses had been recognized and properly provided for in the beginning, we would not hear so much about the vital necessity of care and skill in mixing the concrete for reinforced concrete structures, for any fairly good concrete would have done

Mason Warehouse
Reinforced Concrete
Johnson St., Brooklyn

Effect of Fire on Timber Mill Construction
Columns, 16″ x 16″ Yellow Pine. Beams, 2-8″ x 16″ Y. P. Bolted
Floors, 6″ Plank Y. P. Finish 1″ Y. P. Brick Walls

the work required of it with success. It is because we are demanding of concrete duty for which it is not fitted, no matter how good, but which it performs better than we have a right to expect, that its quality is such a sensitive point.

To require attached web members does not particularly favor any patented system, for the principle is public property, and there are many ways to apply it. If a patented system furnishes the best and cheapest method of applying an established principle, however, that is not a vital reason for not requiring the principle to be applied.

If I were writing the building regulations of a large city, I should prescribe that where a system of adequately designed attached web members was used in the floor system, the percentage of reinforcement might be as high as 1¼; otherwise it should not exceed ¾. That would shortly settle the whole question.

Another point which I think is of extreme importance is that high carbon steel should be discouraged, or at least, it should not be permitted to be used with working stresses exceeding those allowed for medium steel, because, otherwise, dangerously large deformations in the concrete will result. Until we find a way to increase the modulus of elasticity of high carbon steel in proportion to the increase in its elastic limit, its greater strength cannot possibly be utilized in reinforced concrete, without serious dangers.

There are many other points that ought to be covered in design of reinforced concrete buildings, such as the transmission of load from an upper column to a lower, the details at the floor levels, where the floor loads are taken into the columns, etc., etc. But, as I am not submitting a proposed draft of building regulations, I will not go into them now. If, however, all the points above mentioned are properly covered by regulations, there is no doubt that reinforced concrete is just as safe as protected structural steel, and in many places, more suitable and economical. It has certainly earned the right to full official recognition."

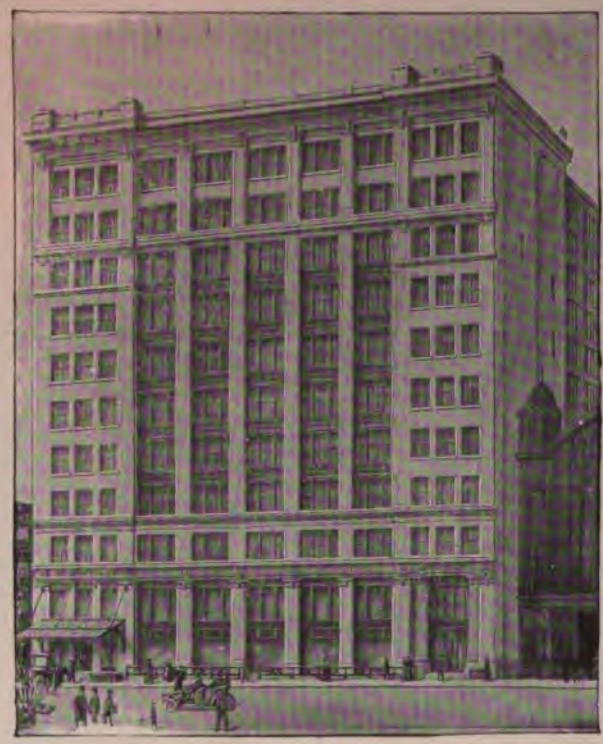
We also take pleasure in submitting the following letter from Mr. Rudolph P. Miller, M. Am. Soc. C. E., late Chief Engineer Bureau of Buildings, Borough of Manhattan. Inasmuch as reinforced concrete has reached its present high state of development in this community under Mr. Miller's supervision in his official capacity, his letter will undoubtedly be read with great interest and his opinions must be given the highest consideration.

OPINION OF MR. RUDOLPH P. MILLER, LATE CHIEF ENGINEER BUREAU OF BUILDINGS, BOROUGH OF MANHATTAN.

"It is with pleasure that, in response to your request, I give you herewith my views on the provisions affecting reinforced concrete in the proposed new Building Code. It was my privilege, as Chief Engineer of the Bureau of Buildings, to write the first regulations governing reinforced concrete that were promulgated and used in this country. These regulations have been in force in New York since their adoption in 1903, and have, I am pleased to say, proven very satisfactory. It has been a great gratification to note also that they have served as the basis for practically all other municipal regulations on reinforced concrete adopted in this country, many of the clauses having been copied verbatim.

With certain changes prompted by a larger experience and further study, the present regulations for Manhattan could be wisely adopted in the new code as the provisions relating to reinforced concrete. I know they are not acceptable to the extreme concrete enthusiasts, because they do not permit a free hand to contractors; nor are they satisfactory to the opponents of concrete construction, because they do not prohibit the construction. I think, it is fair to say, that they are generally admitted by unbiased judges to be safe and conservative and representative of good present day practice.

It was always a matter of regret to me that I did not succeed in having the fireproof character of concrete investigated



11-story Reinforced Concrete Printing House
McGraw Publishing Company
239 West 39th St., Manhattan

Monolith Building
34th St., near Broadway, Manhattan
12 stories Reinforced Concrete

by the city authorities, and that it, therefore, became necessary to have each representative of a system make a separate fire test. It seems to me, however, that now, after the score of fire tests on stone-concrete made under the auspices of the Bureau of Buildings, sufficient proof has been adduced to show that reinforced stone-concrete is fireproof. I would strongly advocate the elimination of the second clause of the present regulations, regulating the fire test, and inserting instead such provisions as may be deemed necessary to secure sufficient protection for the imbedded reinforcing material. With such safeguards, there is no reason why reinforced concrete should not be classed with other acceptable forms of fireproof construction.

And let me say here, that I consider it a mistake to attempt, in a building law, a grading of fireproof construction. The law should fix one standard of fireproof construction, making that, I would strongly urge, a high one, based on the very large and extensive experience of the Bureau of Buildings. A distinction between so-called first class and second class construction will be found impracticable in the administration of the law, and is almost certain to lead to misunderstanding if not discrimination.

A limit of height has been suggested for concrete construction. That seems to me entirely unnecessary. Structural safety and ability to resist fire are the only considerations that I can conceive as affecting this question. But, so long as the working stresses fixed by the law are not exceeded, there need be no fear of going to any height; and, with all the safeguards against fire provided for by the law, a reinforced concrete structure is quite as safe as any other or else it cannot be considered fireproof.

One element of a reinforced concrete structure that should have a fuller consideration in the law, is the column. The present provision is very meagre. In the light of our later knowledge, three types of columns may be considered: The

plain reinforced column, the banded or spirally wound column, and the steel-core column which is so strongly advocated in Philadelphia.

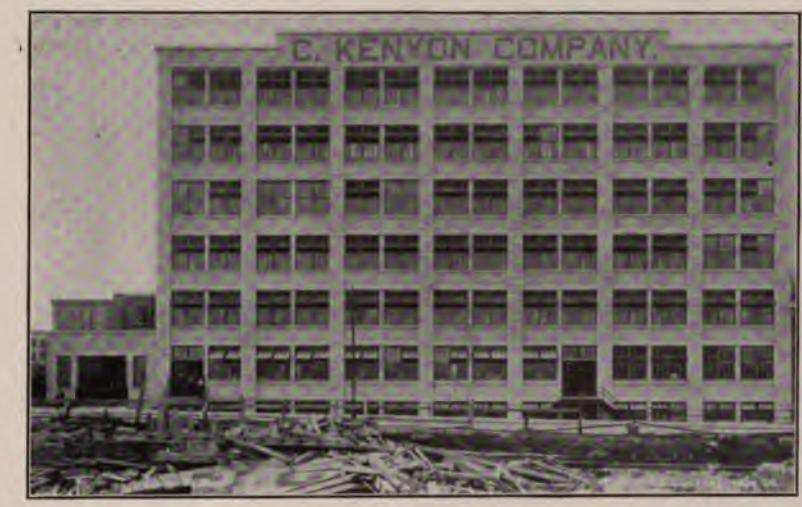
In the consideration of this subject for the Building Code Revision Commission of last year, the suggestion was made that all the shear in members subjected to transverse loading should be taken up by means of stirrups and that these should be firmly attached to the tensional reinforcement. I do not favor such a provision, as I believe that any type of construction which is safe should be permitted. It is entirely a matter of design under the established working stresses. It would be quite as unfair as to require the use of a mechanical bond between concrete and steel.

The present regulation (No. 18) with respect to load tests, is unfair and in some cases may prove unsafe. It is now required that in a test, the applied load shall be three times the contemplated load. This might, under certain circumstances, stress the steel beyond its elastic limit. I would suggest a change to one and one-half times the working live load plus one-half the weight of the construction.

It has been proposed to prohibit the placing of concrete in freezing weather. This is an unnecessary hardship, as entirely successful work can be done in extreme cold weather with proper precautions.

The fixing of a minimum time for removal of the forms, as has been also suggested, is not desirable, in my opinion, as it is likely to be used as an excuse in many cases for the premature removal of forms. In this connection, I might add that any provision restricting building undertakings to reliable and responsible contractors would be to the interest of reinforced concrete, as well as other constructions, and would make many of the requirements in the law superfluous.

I am sending you a draft of a section on Reinforced Concrete, which I believe, would represent good conservative present day practice.



Reinforced Concrete Factory Building
C. Kenyon Company
Pacific Street, Brooklyn

600-ft. Reinforced Concrete Factories
Bush Terminal Company
39th Street, South Brooklyn

(Inasmuch as we submit herewith a specification for reinforced concrete which follows closely the lines laid down in Mr. Miller's proposed draft, we have considered it unnecessary to reprint the specification which he submits.)

Fires in Reinforced Concrete Buildings.

We call your particular attention to the following report of a serious fire which occurred in the Thompson & Norris Building, Borough of Brooklyn:

"There was a fire on the seventh floor of this building which burned up the entire contents of the floor consisting of cork and paper stock. The loss was estimated at $10,000. The damage to the building consisted in the cracking of the concrete below the reinforcement on two beams, but this was repaired for a nominal sum. On the floor above the fire were a number of printing presses which were run next morning as usual, no sign of damage extending to that floor. The fire occurred in the afternoon and the employees quietly walked out of the building without fear of harm and the office force remained at work in the building during the fire. Some damage was done to the building by the firemen breaking the wire-glass windows to let out the smoke. After failing to break holes in the floor slab with axes, in order to let the water run off qnickly, the firemen secured a piece of cold rolled shafting and using this as a battering ram, managed to punch some holes in the floor and let the water through damaging the stock below."

Please take note also of the following record of a fire which occurred in the Dayton Motor Car Works, at Dayton, Ohio, as described in the "Engineering Record" of March 28th. This is a very important record of a serious fire in a reinforced concrete building, and gives good evidence of what may be expected.

Fig. I. General View of the Burned Dayton Motor Car Buildings

THE FIRE AT THE DAYTON MOTOR CAR WORKS.

By J. B. Gilbert.

A serious fire at the plant of the Dayton Motor Car Co., Dayton, O., briefly mentioned in The Engineering Record of March 14, has furnished a very interesting demonstration of the efficiency of reinforced concrete as a fireproof building material. No more convincing exhibit could possibly have been made than that set forth in the following notes.

The main portion of the factory consists of a mill-construction building of five stories and basement, adjoined by a reinforced concrete building, U-shaped in plan and six stories and basement in height; in fact the two buildings were practically made a continuous unit, as the walls of the brick building served as the boundary of the concrete building on the open side of the U, communication being afforded between the two buildings by doors on each floor. It will be necessary to bear this in mind to understand properly the description of the events to follow.

The concrete building was erected during the summer of 1907 by the Keppele Hall Co., consulting engineers and contractors, of Dayton. The system of reinforcement employed was a combination of the Kahn trussed bar, the cup bar and the Kahn expanded metal, all products of the Trussed Concrete Steel Co., of Detroit. The only feature of the building which was not absolutely fireproof was the window frames and sash, which were of the ordinary wood construction.

At 2 a. m. Friday, Feb. 21, fire broke out from some unknown cause on the fourth floor of the new building, which floor contained the upholstery department of the factory. On this floor were large quantities of excelsior, curled hair, dry wood, composing bodies of automobiles, and other inflammable

materials in large quantities. The fire soon spread over the entire fourth floor of the concrete building, and, not being impeded in its progress by fire doors between the new and old building, the flames were soon communicated to the old building, where the greatest damage was done. When the fire department arrived on the scene it was apparent at a glance that the greatest destruction would be in the old building, and the chief of the department directed his men to confine their attention to it and allow the reinforced concrete building to take care of itself. Results fully justified the confidence which he placed in this type of construction. The fire burned itself out on the fourth floor of the new building, and, in burning out the window frames and sash, the flames licked outward and upward, and in some few instances burned the sash out of the windows above on the fifth floor, but not enough to cause any serious damage.

It was not long before the fire was confined to the old building, and inside of three hours the fourth and fifth floors and roof had fallen down onto the third floor, a charred mass of ruins. The fire was stopped at this point, but the building is a wreck. The walls remain standing and may be fit for a new interior, but even they bear a pathetic and eloquent testimony to the inefficiency of that type of construction under stress of fire.

The heat under the ceiling of the fourth floor of the new building was so intense that the iron pipes of the sprinkler system were bent completely out of shape, in some instances having sagged clear down to the floor. It should be stated that the automatic sprinklers were just being installed, no water having as yet been turned into the pipes. Thus the burnt area was unprotected from that source. Throughout the building wood plugs about 2 x 3 in. had been inserted in the under side of the floor panels for convenience in attaching electrical wires. The heat was so intense that these, although exposed on only one small surface, were in many cases burned

Fig. 2. Factory Building, Dayton Motor Car Co.
Showing effect of fire on a reinforced concrete structure. All window frames were of wood.

completely out, leaving an empty hole in the concrete. Yet, despite this intense prolonged heat, the strength of the building was not impaired in any respect or at any point. At one place where the fire was most intense the concrete spalled off from the corners of two beams for a length of about 4 ft. and a width of about 2 in. No cracks are discoverable either in the floor panels or in any beams and girders.

One point was brought out by this fire that has a very practical bearing on the treatment of finished cement floors on a reinforced concrete slab. The concrete entering into the construction of this building was a 1:2:4 mixture, while the finished coat of 1 in. in thickness was the usual mixture of one part cement to two parts sand. The finish coat was applied as soon as possible after the main slab had been poured, but, very naturally, after it had taken its initial set. The two mixtures, differing as they did and being poured at slightly different times, inevitably furnished different degrees of shrinkage in the process of setting and drying out. The consequence was that the union between the two was imperfect. When subjected to a test by this fire the unequal expansion of the main slab, increased by the expansion of the steel imbedded in it and of the finish coating, gave rise to irregular cracks through the finish coat. Where the heat was greatest the finish coat separated from the slab and bulged up in great molds. All this coat throughout the burned area has had to be replaced.

Another point of interest more especially to builders in the territory adjoining Dayton is the effect of this fire on the aggregates used in pouring this building. The chief ingredient in point of bulk was washed river gravel, 1 in. in diameter and smaller. Its splendid resistance to this fire demonstrates beyond the shadow of doubt its fitness for this use. Had this aggregate contained any considerable amount of free lime in its composition the fire would certainly have proved disastrous.

It is interesting from the manufacturers' standpoint to know that within two days after the fire the machinery was running in this building and operations were resumed. The two days mentioned were consumed in clearing away the debris incident to such a fire. The fourth floor, where the most damage was done, was piled to its full capacity with salvage from the stock stored in the destroyed brick building, thus proving its safe condition.

It is safe to say that if the fire doors had been in place between the new and old buildings, so as to confine the fire to the floor on which it originated, the damage would have been trifling, even though the sprinkler system was not in operation. The fire department could then have devoted some attention to the concrete building and checked the flames before they had burned themselves out.

In the accompanying illustrations, Fig. 1 shows a view of the burned buildings looking toward the brick structure. From this it is evident what happened. The two top floors of the brick building are entirely wiped out, and the damage to the concrete building is confined to the window frames and sash. Fig. 2 shows a view of the concrete building on the opposite corner, from which it is apparent that the damage on this side was also confined to the fourth floor window frames and sash. Fig. 3 shows the south side and west side of the building, on which the damage was about the same as the other views show.

Fig. 4 shows an interior view at the point where the fire burned hottest. It shows the contents of the floor reduced to ashes, and on the ceiling shows the only two places where the concrete spalled off on the corners of a beam and girder. This spalling off occurred after the fire was out, during the process of cooling off and consequent contraction. The steel was not exposed during the fire. A rough surface is noticeable on the second column shown in this view. This was roughened with a hammer after the fire to determine what condition it was in.

Fig. 3. Reinforced Concrete Factory Building, Dayton Motor Car Co., after the Fire of February 20, 1908

Fig. 5 is another interior view, showing broken condition of the cement finish coat and distorted sprinkler pipes and heating pipes. Fig. 6 shows a view of the interior court, where it may be seen how the fire damaged the sash in some cases on the floors above. It will be noticed also that the sash on the third floor are damaged. This came about by burning parts of the fourth floor windows falling down on the roof of an adjoining building and communicating the fire to them.

In order to ascertain whether the structure had been damaged to any extent or had been weakened by the fire, it was decided to make a load test on the floor above that on which the fire originated. Before making this test a careful examination of the concrete on the under side of the beams and girders was made, and all of the concrete which had become vitiated by the intense heat was knocked off with a hammer. In some cases this exposed the steel reinforcement. The beams and girders which were most seriously affected in this way were selected as the ones on which the test should be made. The building was designed for a live load of 120 lb. per square foot, and the girder over which the test was made had a span of 22 ft. Equal areas on both sides of this girder were loaded so as to give a uniformly distributed load The area covered was 352 sq. ft., on which were piled 77,250 lb. of pig iron, fly wheels and any available heavy material which could be obtained at the plant. This gave a uniformly distributed load of about 218 lb. to the square foot, and under this load the girder in question showed a deflection of only 3/16 in. at the center of the span. Had more material been available the test would have been carried further as a matter of interest in determining how much of a load could be carried before an alarming deflection was reached in the girder. The owners, however, on observing the amount of material which had been piled on the floor, were so thoroughly convinced of the stability of the structure and of the fact that in practice it would be impossible for them ever to load their building to such an extent, that

they did not feel it at all necessary to go any further by obtaining materials elsewhere for the heavier loading.

One fact of great importance was very thoroughly demonstrated, namely, that the utmost care should be used in so placing the steel that it will remain in position during the pouring of the concrete. In this building the greatest care had been exercised to secure this condition, but in spite of all precautions it was found that in some few cases the steel reinforcement was within ½ in. of the surface. The fact that the steel remained uninjured even under this condition is a very high recommendation as to the fire-resisting qualities of concrete, but a warning to use the utmost care in seeing that the steel is not misplaced during the process of pouring the concrete. In the majority of cases in this building the steel was imbedded at the proper depth.

Since receiving the above article the following letter from Mr. Frank B. Ramby, chief of the Dayton fire department, has been obtained for publication from the Trussed Concrete Steel Co., to which it was sent:

"In reply to your favor of the 10th, in which you refer to the recent fire in the new reinforced concrete building at the Dayton Motor Car Co.'s plant, I would state that, this being the first fire we have had in a building of concrete construction, I am highly pleased with the results of this fire. When I arrived on the scene the fire had extended over the entire fourth floor. The entire contents of this floor were destroyed. The building, however, escaped with slight damage.

"Through the absence of fire doors and the inability of our department being able to withstand the intense heat and smoke, the fire communicated itself through an opening into the adjoining five-story brick building and was confined to the two upper floors. The biggest fight was carried on here, and it was in this building that the greatest loss was sustained.

Fig. 4. Where Fire was Hottest

Fig. 5. Broken Floor Finish

The lower floors being occupied by the offices and warerooms of the company, suffered greatly from water.

"The new building, being of concrete construction, aided us greatly in preventing the fire from wiping out the entire plant, as we were able to concentrate practically our entire force on the old building, it requiring but a small force to subdue the fire in the concrete building.

In my opinion, there are a few points that the results of this fire have proven, namely:

FIRST, that the reinforcing steel should be covered with at least 2 in. of concrete, because the fire, having penetrated the lower inch of concrete would have injured the strength of the structure had it not been for the rigidly attached diagonals.

SECOND, that the finished cement surface should be put on when the floor is being laid, thereby forming a solid mass, because the finished surface was destroyed wherever the heat was intense, the slab underneath being uninjured.

THIRD, as we were hampered greatly in handling our ladders and several of our firemen had a very narrow escape from being injured or possibly killed by falling sashweights, and we were compelled to force into the building all window frames that had not already fallen before we could use our ladders to advantage, I would suggest that in the construction of a building an iron pipe be imbedded in the concrete for weights to fall into, in case the window frames are destroyed by fire. If this plan were adopted in the construction of a building it would enable the firemen to reach the fire without endangering their lives and would assist greatly in reducing the fire loss."

THE KEPPELE HALL COMPANY

CONSULTING ENGINEERS AND CONTRACTORS
REINFORCED CONCRETE CONSTRUCTION
1111-1114 U. B. Building

DAYTON, OHIO.

DEAR SIRS:

On March 15th we made a test at the building of the Dayton Motor Car Co. to determine whether the structure had been injured by the recent fire. For this test we selected one of the 22-ft. span girders immediately over the hottest part of the fire, this being the one on which the concrete appeared to be most affected. We applied the load to a half panel on each side of this girder, covering an area of 22′ x 16′. The building as you know, was designed for a load of 120 lbs. to the square foot. We secured all the available pig iron at the plant and a number of heavy fly-wheels and other metal parts until we had loaded this section to 77250 lbs., or a load of about 219 lbs. to the square foot. The deflection at the center of the girder under this load was $\frac{3}{16}''$. We were very anxious to continue this test until we had obtained a deflection of $\frac{3}{4}''$ or 1″ on the girder, but there was no more material about the plant which could be conveniently obtained, and Mr. Houk, the General Superintendent, who was present at the test, felt perfectly satisfied that the building had been in no way injured by the fire, and thought it unnecessary to carry the test any further.

We are enclosing a photograph showing the pig iron piled on trucks on the floor. To our notion the most instructive feature of a load test on the floor of a building is the impression produced upon the owner when he actually sees the material piled up on the floor. This conveys a very much clearer idea of the strength of the building to the average layman than to simply state that the building was designed to

Fig. 6. View of Interior Court of Dayton Motor Car Works

Fig. 7. — Dayton Motor Car Co.'s Factory Building

carry a certain number of pounds per square foot, and in this particular case Mr. Houk was impressed with the fact that under no possible circumstances could their building ever be loaded to anything like the extent to which it was loaded during the test. We feel that the whole experience of the fire at the Dayton Motor Car Co.'s plant is of great value to the cause of concrete building in general, and to ourselves in particular.

We might also advise you that we have completed all of the repairs to the building, including the relaying of the facing coat on the fourth floor, and the patching up of the columns and girders. This latter portion of the work consisted in knocking off from the corners of all beams and girders any concrete which had deteriorated under the action of the heat and repatching same so as to put the concrete in its original condition as to protection of the steel reinforcement. The entire expense of this repairing of the concrete work in the building, including the refinishing of the floor facing, amounted to less than $500.00.

Very truly yours,
THE KEPPELE HALL COMPANY.
KEPPELE HALL,
President.
J. B. G.

A fire of quite a serious nature occurred in the Bowling Green Storage and Van Company's Building on 65th Street, Manhattan, without any material damage to the structure. The protection to the steel in these buildings did not exceed 2".

We believe the citizens of New York are entitled to the benefits accruing from this type of structure and that reinforced concrete should be permitted for use in all classes of buildings of whatever nature or kind, without restriction as to height or area, beyond those made in other classes of construction. We ask that reinforced concrete be admitted on an absolute equality with other types of construction. If,

in your wisdom, you deem it necessary, we will acquiesce in having the reinforcing steel protected with the same amount of concrete that you specify for steel structures in the like classifications, although we would call your attention to the fact that, based upon all the tests made by the New York Department of Buildings, and upon experience thus far had from fires in various parts of the country, particularly in Baltimore and San Francisco, as well as in the buildings above noted, 3″ of protection to the steel is entirely adequate under any circumstances. It is true that failures occurred in some instances in San Francisco, but you will observe from photographs of such failures a total lack of stirrups, a protection of less than 2″, and a general faulty design, which should have due consideration before judgment is passed. We ask that your Committee will visit the more important of the buildings shown on the list attached hereto and investigate the characteristics of these buildings from the standpoint of the owner, their economy speed of construction, nature of loads and machinery, and the amount and character of insurance carried on these structures.

PARKER BUILDING.

We would call the attention of your Committee to the construction of the Parker Building at Fourth Avenue and Nineteenth Street, and particularly to the extraordinary relative resistance to shocks of the terra cotta arches of the main floor and cinder concrete arches of the pent-house, built along the northerly side of the roof. Due to the collapse of the columns, a section of the pent-house roof collapsed. It will be noted that the terra cotta arches on the 6 foot spans fell through in many cases, even though the wooden floor over them was not burned, whereas a section of the cinder concrete roof of the pent-house, substantially 15 feet wide and 22 feet long was held in suspension over the opening caused

Parker Building, New York

This opening is not a court, but was made by the collapse of a cast-iron column, carrying away the entire floor structure from roof to basement. Beyond may be seen the 6′ 0″ arches that fell out. In many cases the wooden floor above the fallen arches was left intact

Parker Building, New York.
Opening caused by collapse of cast-iron column, and general wreck of a building with tile floors, and called fireproof.

Parker Building, New York.
Compare this with the fire of a similar nature which occurred in the Dayton Motor Works.

by the collapse, without doing substantial damage to the arches themselves. In other words, the terra cotta arches fell out from the impact of a very small load on the wooden floor, but the cinder concrete arches stayed in place even though the steel structure was wrecked. This presents a very interesting commentary on the relative values of arches of two materials built under ordinary conditions, in resisting shocks.

Exhibition of Concrete Construction.

There is a permanent exhibition of cement, concrete and reinforced concrete, which has been installed on the 11th floor of the Brunswick Building, Fifth Avenue and 25th Street, and we trust that your Committee will visit this exhibition as we believe you will find it very instructive and interesting.

Concrete Fireproof Arch Construction.

In regard to fireproof arches on steel structures, we beg to call your attention to the many hundreds of buildings which exist in this community and which also speak for themselves, particularly in respect to buildings regarded as first class, such as power houses, factories, manufacturing plants, refineries and buildings where the heaviest merchandise and machinery are installed. Notable structures of this type are

Building.	Location.	Architect.
Main Power House, Interboro R. R.	59th Street	McKim, Mead & White.
N. Y. Sugar Refinery	Long Island City	Louis Engle.
Waterside Station, N. Y. Edison Co.		C. P. Hoppe.
Butterick Building	Spring St.	Horgan & Slattery.
Mills Hotel No. 1	Bleecker St.	Ernest Flagg.
Mills Hotel No. 3	Seventh Ave.	Copeland & Dole.
Scribner Press	West 43rd St.	Ernest Flagg.
Varick Warehouse	Washington St.	W. H. Birkmire.
Macy Dept. Store	34th St. & Bway	Delemos & Cordes.
Printing House, Met. Life Ins. Co.	24th Street.	M. LeBrun & Son.

Building.	Location.	Architect.
Power Building	Houston St.	C. H. Caldwell.
Y. M. C. A.	24th Street	Parrish & Schroder.
French Hospital	34th Street	Welsh & Provost.
Hotel St. Regis	55th Street	Trowbridge & Livingstone.
St. Cleaning Stable	Kent & Flushing Aves., Bklyn.	Warren & Wetmore.
J. J. Little Printing House	East 24th St.	Townsend, Steinle & Haskell.
Metropolitan Life Tower	1 Madison Ave.	M. Le Brun & Son.
Warehouse	Bleecker St.	Ralph S. Townsend.
The Borgfeldt Bldg	Wooster & W. 4th	Alfred Zucker.
Office and Warehouse	Park Ave. & 125th.	C. P. H. Gilbert.
Residence, Andrew Carnegie.	5th Ave. & 91st.	Babb, Cook, & Willard.
Bldg. 30, U. S. Navy Yard	Brooklyn.	P. C. Asserson.
Engine House	33rd St. West to 6th Ave.	Horgan & Slattery.
Substation Edison Electric Illuminating Co.	311 W. 84th St., 32 Horatio St., 358 W. 124th St., 128 E. 121st St.	
Lupton Printing Est.	33 City Hall Pl.	W. B. Tubby & Bro.

Reinforced concrete arches have been used to a very large extent, with the utmost success in these buildings. The arches are of two types, either segmental or flat, and we call your attention to the fact that where the reinforcement goes over the top flange of the beam a properly designed flat arch which protects the structural steel on sides and bottom, is in every respect as efficient as segmental arches and is often cheaper and more easily constructed. We, therefore, ask that in all buildings of this kind, you will specify the use of cinder concrete and reinforcing bars or mesh, built either segmental or flat.

Cinder concrete should provide for a mixture of not more than one part cement, two parts sand and five parts of clean steam cinders. The thickness of the arch, whether flat or segmental should not be less than $\frac{1}{4}$" for each foot of span and in no case be less than $3\frac{1}{2}$". The lower flanges of beam should be protected by 2" of concrete reinforced and fastened to the flange by means of metal lath, wire or metal clamps. The same provision should be made for girders, in-

National Bank of Commerce Building
Baltimore, Md.
Showing excellent condition of reinforced concrete floor after being subjected to an intense heat.

Calvert Building
Baltimore, Md.
Showing failure of terra cotta floor tile and terra cotta tile encasing steel columns.
Note buckled column resulting from this failure.

creasing the thickness to 3″. Columns should be covered with 4″ of concrete except lugs and projections which should be covered with 2″ of concrete. Where terra cotta is used for this class of building, the protection should be equivalent and the hollow spaces in brick or tile should not be taken into consideration.

All constructions which have thus far passed the fire and load tests of the Department of Buildings, should govern the design for every system, and variations from that record should be allowed by taking into consideration the cross section of metal and thicknesses of the concrete proposed, but in all cases where such variation is asked for, the Department of Buildings may first require a load test on full-size specimens built as proposed.

Reticulated or mesh steel should be valued in accordance with the cross section and character of metal used, but in no case should such mesh weigh less than ½ pound per superficial foot of area. The provision that this mesh should weigh at least 1 pound to the foot is entirely unnecessary. There is very little mesh steel on the market which weighs 1 pound to the foot, and yet millions of feet of mesh have been used throughout this community on these structures with entirely satisfactory results.

The code should provide that holes may be cut in concrete floors up to 2′-6″ square without additional structural steel. This is based on experience and is entirely within good practice as shown on nearly every building that is built.

Reticulated or mesh steel should provide that the mesh in no case should be less than 8 sq. in. This is an ample opening and gives a secure hold. Furthermore, where the cross section of the metal is sufficient and the metal weighs more than ½ pound to the foot a mesh of 8 sq. in. is distinctly superior to a large mesh and should be so considered.

Where hangers and supports are fastened to the under

flanges of beams and girders, provision should be made that wherever the fireproofing is broken away to use such hangers, it shall be made good before the work is covered. The provision that these hangers shall be put in place before the concrete fireproofing is placed, is impracticable, except patented devices.

On second class structures, hotels, apartment houses, office buildings, and the like, the same specifications for concrete arches should be made with the exception that the reinforcement need not be carried over the top flanges of the beams and the protection to the steel on the underside of the beams, girders and columns may be made by wrapping the beams, girders and columns with metal lath, and covering with cement mortar or concrete, and reducing the thickness by one inch.

Fire Test.

We wish to call the particular attention of your honorable committee to the subject of fire tests. As you are well aware the present building code imposes very severe restrictions upon the introduction of new material or new forms of construction. A large number of fireproof constructions have successfully withstood these requirements. They have cost a great deal of money, approximately $2,000 each and those that have successfully passed the test constitute an unimpeachable record of the efficiency of the several kinds of construction. We respectfully submit, therefore, that all of these constructions should be considered standard of their respective types. The recent Revision Committee made provisions in regard to fire tests which were not only entirely unnecessary and put extraordinary powers in the hands of the Superintendent of Buildings, but in effect eliminated the record already made by the systems which have successfully passed the code requirements. This is certainly not justifiable and all of the tests which have thus far been made under the rigorous con-

Calvert Building
Baltimore, Md.
Showing excellent condition of cement plastered metal lath suspended ceiling, where fire was fully as hot as in the floor shown in the previous view

Calvert Building,
Baltimore, Md.
Showing disastrous effect of fire on terra cotta tile

ditions of the present code, should be recognized and permitted to be used in accordance with their several records. Furthermore, the additional restrictions formulated by the recent commission are entirely unnecessary and inimical to the best interests of the public. It gave into the hands of the Superintendent of Buildings the power to practically debar any new construction to which he might be unfriendly. The development of many excellent constructions in the past few years simply gives evidence of the probable invention and development of new and improved systems which the public should be entitled to use, subject to the tests laid down in the present regulations. These tests are severe in the extreme and are amply sufficient to determine the structural and fireproof efficiency of any system. Nothing further is needed in this direction to amply protect the public. We would call attention however to the fact that the making of a fire test is of little protection to the public unless the firm making the test is made responsible for all the work done in the community under the system tested. The practice is common for firms to make a test in which certain reinforcing material is used and for such firm to sell the material indiscriminately for construction by anyone. The public would be better protected should the law require the firm who makes the test to be responsible for all work erected in the community under its system. This is much more important than the fire test itself and more is to be gained in securing good construction along this line than by increasing the severity of the fire test which we have already said is entirely sufficient as it now stands.

Reinforced Concrete.

We call the attention of your committee to the regulations laid down by the former commission in respect to reinforced concrete, and while these specifications are very conservative they meet our endorsement with these exceptions.

(1) That reinforced concrete construction should be allowed in cold weather provided that wherever work is done below 28 degrees F. the same shall be protected from freezing and the material entering into the concrete shall be heated. It is entirely practicable and safe to carry on concrete work in any degree of cold provided the materials are heated and the concrete work covered and protected and any provision forbidding concrete construction in cold weather is entirely unnecessary and contrary to good engineering experience.

(2) That the provisions as to the removal of forms and centering should not be under the jurisdiction of the Superintendent of Buildings. The responsibility for the removal of centers is as binding upon the contractor as any other detail of the construction and should be in his hands.

The following is the specification as modified in accordance with the above objections :

SPECIFICATION FOR REINFORCED CONCRETE CONSTRUCTION.

REINFORCED CONCRETE.—The term reinforced concrete shall be understood to mean an approved concrete mixture reinforced by steel of any shape, so combined that the concrete will take up the compression stresses and that the steel will take up the tensional stresses and assist in the resistance to shear.

Buildings of reinforced concrete, when designed in accordance with the requirements of this section, shall be deemed fireproof, and permissible under this Code for all classes of buildings without restriction.

The concrete shall be mixed in the proportions of one part of cement, two parts of sand and four parts of stone or gravel by volume; or the proportions may be such that the resistance of the concrete to crushing shall not be less than 2,000 Pounds per square inch after hardening for twenty-eight days. The tests to determine this value must be made under the direction of the Superintendent of Buildings. The concrete used in re-

Equitable Building
Baltimore, Md.
Showing almost total failure of terra cotta tile floor arches

inforced concrete construction shall be what is usually known as a "wet" mixture.

All cement used in reinforced concrete shall be Portland cement conforming to the requirements of this Code.

The sand shall meet the requirements of this Code.

The stone used in the concrete shall be a clean, broken trap rock, or gravel, of a size that will pass through a three-quarter inch ring. In case it is desired to use any other material or other kind of stone than that specified, samples of same must first be submitted to and approved by the Superintendent of Buildings.

The steel used in reinforced concrete shall meet the requirements for structural steel given in this Code.

Where reticulated or mesh fabric is used for the reinforcement of slabs, the carrying value of such slabs may be taken from records officially established by the Department of Buildings from tests of full size working specimens. The working load allowed on such slab shall be one-half of the load carried by said slab when hair cracks begin to develop.

Reinforced concrete shall be so designed that the stresses in the concrete and the steel shall not exceed the following limits:

	Pounds.
Extreme fibre stress on concrete in compression, per square inch	500
Shearing stress in concrete, per square inch	75
Unreinforced concrete in direct compression, per square inch	400
Tensile stress in steel, per square inch	16,000
Shearing stress in steel, per square inch	10,000

The adhesion of concrete to steel shall be assumed to be not greater than the shearing strength of the concrete.

The ratio of the moduli of elasticity of concrete and steel shall be taken as 1 to 12.

The following assumptions shall guide in the determination of the bending moments due to the external forces. Beams and girders shall be considered as simply supported at the ends, no allowance being made for continuous construction over supports. Floor plates, when constructed continuous and when provided with reinforcement at top of plate over the supports, may be treated as continuous beams, the bending moment for uniformly distributed loads being taken at not less than $\frac{WL}{10}$; the bending moment may be taken at $\frac{WL}{20}$ in the case of square floor plates which are reinforced in both directions and supported on all sides.

When the floor slab is built or cast at the same time as a beam or girder, and is considered as a part of that beam or girder, the width of the slab to be taken into consideration must not be more than one-third the span of the beam or girder, nor more than the distance between beams or girders in case that distance is less than one-third the span.

The moment of resistance of any reinforced concrete construction under transverse loads shall be determined by formulæ based on the following assumptions:

(a) The bond between the concrete and steel is sufficient to make the two materials act together as a homogeneous solid.

(b) The strain in any fibre is directly proportionate to the distance of that fibre from the neutral axis.

(c) The modulus of elasticity of the concrete remains constant within the limits of the working stresses fixed in this section.

From these assumptions it follows that the stress in any fibre is directly proportionate to the distance of that fibre from the neutral axis.

No allowance shall be made for the tensile strength of concrete.

When the shearing stresses developed in any part of a reinforced concrete construction exceed the safe working strength

Continental Trust Building
Baltimore, Md.
Showing disastrous effects of fire upon terra cotta tile; marble finish, attached to tile, failed with tile

of concrete, as fixed in this section, a sufficient amount of steel shall be introduced in such a position that the deficiency in the resistance to shear is overcome.

When the safe limit of adhesion between the concrete and steel is exceeded, some provision must be made for transmitting the stresses from the one material to the other.

All reinforcement in beams, girders or columns shall be so secured or held that there can be no displacement of the same in the concrete.

Where girders or beams rest on columns the reinforcement of the beam or girder shall penetrate the column to secure proper bearing.

All reinforcements shall be completely incased in concrete. The thickness of concrete outside of the reinforcement shall not be less than $\frac{3}{4}''$ in floor slabs, partitions and walls, and not less than 2″ for all beams, girders and columns, and not less than 3″ in footings. For first-class buildings the thickness of concrete outside of the reinforcing members shall be not less than 2″ on beams and 3″ on girders and columns.

Reinforced concrete may be used for columns in which the ratio of length to least side or diameter does not exceed sixteen; but in no case shall the effective cross section of the column be less than 64 square inches.

All such columns shall have longitudinal reinforcement of a total cross sectional area equal to at least one-half of one per cent. of the effective sectional area of the concrete; provided, however, that the total sectional area of the reinforcing steel shall not be less than 1 square inch and that no rod or bar be of less diameter or least dimension than one-half inch. All longitudinal reinforcement rods shall be tied together by wire at least one-quarter of an inch in diameter at intervals of 12 inches. All vertical reinforcing rods or bars shall extend upward or downward into the column above or below, lapping the reinforcement of the column above or below to the extent of at least forty diameters of the rod or bar.

Reinforced concrete columns may be stressed 500 pounds per square inch of the effective area, with no allowance for the compressive strength of the vertical reinforcement.

In the case of circular columns which are further reinforced by bands or spirally wound hoops, the unit working stress shall be the sum of one and one-half times the resistance of concrete in direct compression, and 3.14 times the unit lateral resistance of the bands or hoops when stressed to not more than 16,000 pounds per square inch; provided, however, that sufficient hooping shall be used to insure a lateral resistance of at least 65 pounds per square inch, but no more than 100 pounds per square inch, and, provided further, that the hoops shall not be spaced more than one-seventh of the diameter of the spiral.

The effective area of a column shall be taken as the area of concrete within the lines connecting the vertical reinforcement in plain columns and within the hoops or bands in the case of hooped columns.

Columns in which the reinforcement consists of steel shapes of sufficient cross sectional area to take the entire dead and live load as provided in this Code, and so designed as to resist buckling under that load, and which have the space within those shapes solidly filled with concrete, may have the steel stressed to 16,000 pounds per square inch.

Spandrel walls supported entirely on reinforced concrete or steel girders shall have a minimum thickness of 8 inches and shall be reinforced with not less than one-half pound of steel per square foot of wall.

The contractor must be prepared, on the request of the Superintendent of Buildings, to make load tests, at his own expense, on any portion of a reinforced concrete construction within thirty days after erection. The test must show that the construction will sustain a load of two and one-half times

Union Trust Building
Baltimore, Md.

Showing method of repairing terra cotta tile ceiling, destroyed by fire, by means of a light steel frame covered with wire lath and plastered with cement mortar

the live load for which it was designed without dangerous deflection or any sign of failure.

No reinforced concrete work shall be done at a temperature below 28° F. unless the materials entering into the concrete are heated and the work is immediately covered and protected to prevent freezing. In case freezing occurs the forms for centers shall not be removed until it has been determined that the concrete is thoroughly set.

HOLLOW BUILDING BLOCKS.—Moulded hollow building blocks, of concrete, terra cotta, or other hard, incombustible material may be used for the walls, except the party walls, of any building not more than 35 feet in height, or for the inclosure walls of skeleton buildings, provided the materials are not stressed beyond the safe limits fixed in this section.

No such blocks shall be used until complete and satisfactory tests have been made by the manufacturer under the direction of the Superintendent of Buildings, in accordance with the requirements of this Code, and until an approval for the use of such blocks has been obtained.

No blocks shall be approved that do not at the age of twenty-eight days develop a compressive strength of at least 1,500 pounds per square inch of net section.

Combinations of blocks and reinforced concrete may be used for bearing walls of structures not more than 40′ 0′ in height under such regulations as may be established by the Superintendent of Buildings.

All such walls shall be laid in Portland cement mortar.

No wall composed of hollow blocks shall be loaded in excess of 100 pounds per square inch of the gross section of the wall; that is, no deduction being made for the hollow spaces in figuring the area.

Where beams or girders rest on such walls, suitable templates of iron, steel or stone shall be provided under their ends, or the blocks under them shall be made solid.

All decisions and regulations established by the Superintendent of Buildings shall be immediately posted in a conspicuous place in the office of the Superintendent of Buildings for a period of not less than sixty days.

ARGUMENT PRESENTED

BEFORE

COMMITTEE ON LIMITATION OF HEIGHT AND AREA

OF THE

COMMISSION FOR THE REVISION

OF THE

Building Code of New York

MARCH 6, 1908

BY

ROSS F. TUCKER, M. AM. SOC. C. E.,
President, Concrete Association of America.

COMMITTEE.

CHARLES G. SMITH, *Chairman*,
THOMAS L. HAMILTON,
EDWARD F. CROKER,
PATRICK J. BYRNES,
CHARLES H. CULLEN.

GENTLEMEN: On behalf of the Concrete Association of America, I have the honor to submit to you the following memorandum, relative to the question of height and area of buildings to be hereafter erected in Greater New York, in so far as the same refers to concrete construction.

FIRST: The Concrete Association believes that steps should be taken with a view to regulating the heights and areas of buildings to be hereafter constructed.

SECOND: In a separate brief the Concrete Association will submit to another committee of the Building Code Revision Commission the details of the specification and regulations governing the design and classification of concrete structures.

THIRD: The Concrete Association desires to call the attention of your honorable committee to the fact that many structures of reinforced concrete exist in Greater New York, each and every one of which constitute an eloquent argument for this type of structure. Among the important buildings of this type we will enumerate the following:

The 12 story McGraw Building on 39th Street, used by the McGraw Publishing Company, publishers of the "Engineering Record," carrying heavy loads, heavy machinery and inflammable material.

The 10 story McNulty Building, 52nd Street and 11th Avenue, carries heavy loads of paper and machinery.

The Monolith Building, 12 stories, on 34th Street near Broadway, an office building.

Bowling Green Storage Building 7 stories, on 65th Street and West End Avenue.

The model factories of the Bush Terminal Company in South Brooklyn. Very large structures, carrying heavy loads and used for general manufacturing purposes.

The 7 story Cavanagh Building in Hope Street, Brooklyn, carrying heavy loads and machinery.

The Robert Gair Building near the easterly end of the Brooklyn Bridge.

The Thompson-Norris Building in Brooklyn, a paper warehouse. A serious fire occurred in this building without substantial damage to this structure.

The Huyler Building.

The Eastman Kodak Building.

The Rogers & Pyatt Building.

The Packard Garage.

The Commercial Trust Company Building, 41st Street and Broadway.

The Automobile Club of America Building.

The Siegle Color Works, on Staten Island.

The J. B. King Buildings, on Staten Island.

And various others.

All of the above buildings are important structures, many of them running above 150 feet in height and nearly all of them being over 85 feet in height.

We submit for your consideration the following extract from a recent statement published by Professor William H. Burr of Columbia University:

"For stiffness and strength as well as fire and earthquake resisting qualities and in general durability, steel concrete has no successful competitor nor is any in sight."

This statement coupled with the foregoing examples of standard construction in steel concrete, should have great weight in emphasizing and substantiating the two essential facts which we desire your committee to thoroughly appreciate: namely, first, that the rules of design established by the building code naturally restrict the height to which reinforced concrete structures may be carried; second, that concrete shall receive the same recognition and be confined with the same limitation as other forms of fire-proof construction and that the committee shall not discriminate in any manner as between reinforced concrete and other forms of construction as far as the questions of height and area are concerned.

The Concrete Association extends an invitation to your committee to visit the Permanent Exhibition of the Concrete Association, 11th Floor, Brunswick Building, 25th Street and Fifth Avenue, New York City, wherein standard concrete constructions and the application of concrete to building structures are thoroughly demonstrated.

ARGUMENT PRESENTED

BEFORE

COMMITTEE ON LIMITATION OF HEIGHT AND AREA

OF THE

COMMISSION FOR THE REVISION

OF THE

Building Code of New York

MARCH 6, 1908

BY

F. G. WEBBER,

President, Masters' League of Cement Workers.

COMMITTEE.

CHARLES G. SMITH, *Chairman*, EDWARD F. CROCKER,
THOMAS L. HAMILTON, PATRICK J. BYRNES,
CHARLES H. CULLEN.

GENTLEMEN :—On behalf of the Masters' League of Cement Workers of New York, I respectfully submit for your consideration, the following brief, relating to the height of buildings of reinforced construction, hereafter to be erected in Greater New York.

1. The Masters' League of Cement Workers is of the unanimous opinion that the heights and areas of all types of buildings should be regulated.

2. The Masters' League of Cement Workers will submit to the Committee on Reinforced Concrete and Fireproofing of the Building Code Revision Committee, a brief dealing with the details of design and classification of all reinforced concrete structures.

3. The Masters' League of Cement Workers would respectfully call to your attention the many existing structures of reinforced concrete in Greater New York, among which the most prominent are the following :—

The Monolith Building, 43 West 34th St., a twelve story office building.

The McGraw Building, West 38th St., occupied by the McGraw Publishing Company, filled with heavy machinery and inflammable material.

The McNulty Building, West 52nd St., a ten story structure carrying heavy machinery and paper goods.

The Commercial Trust Company Building, Broadway and 41st Street, occupied as a banking and office building.

The Packard Garage, Broadway and 61st St.

The Boldt Garage, Broadway and 62nd St.

The Goelet Building, Broadway and 64th St.

The Automobile Club of America Building, West 54th St., an eight story Club house and Garage.

The Huyler Building, East 19th St.

The Nottingham Apartment Hotel, East 30th St.

The Eastman Kodak Building, West 23d St.

The Bowling Green Storage Building, West 65th St.

The Schwarzschild and Sulzberger Stables, East 46th St.
The Bush Terminal Company Factories, South Brooklyn.
The Kirkman & Son Soap Warehouse, Brooklyn.
The Robert Gair Buildings, Brooklyn.
The Kavanagh Building, Brooklyn.
The Thompson-Norris Building, Brooklyn.
The J. B. King Buildings, Staten Island.
The Siegel Color Works, Staten Island.

All of the above buildings are over 85 feet in height and some of them 150 feet high. We cite the list of examples of reinforced concrete construction, to confirm the following facts which we desire to bring to the attention of your honorable committee :—

A. That reinforced concrete structures can be safely constructed to heights over 85 feet.

B. That the limit of the height to which buildings of reinforced concrete can be built is determined by the allowable column values established by the Building Code, making the question of height one of economy and design.

C. That there be no limitations imposed upon the height and area of reinforced concrete structures beyond those established for other types of fireproof construction.